THE MARYLAND ENTOMOLOGIST

Insect and related-arthropod studies in the Mid-Atlantic region

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MARYLAND ENTOMOLOGICAL SOCIETY

The Maryland Entomological Society (MES) was founded in November 1971, to promote the science of entomology in all its sub-disciplines; to provide a common meeting venue for professional and amateur entomologists residing in Maryland, the District of Columbia, and nearby areas; to issue a periodical and other publications dealing with entomology; and to facilitate the exchange of ideas and information through its meetings and publications.

The MES logo features a drawing of a specimen of ***Euphydryas phaëton*** (Drury), the Baltimore Checkerspot, with its generic name above and its specific epithet below (both in capital letters), all on a pale green field; all these are within a yellow ring double-bordered by red, bearing the message "* Maryland Entomological Society * 1971 *". All of this is positioned above the Shield of the State of Maryland. In 1973, the Baltimore Checkerspot was named the official insect of the State of Maryland through the efforts of many MES members.

Membership in the MES is open to all persons interested in the study of entomology. All members receive the journal, ***The Maryland Entomologist***, and the e-mailed newsletter, ***Phaëton***. Institutions may subscribe to ***The Maryland Entomologist*** but may not become members. Prospective members should send to the Treasurer full dues for the current MES year (October – September), along with their full name, address, telephone number, e-mail address and entomological interests.

Annual Dues:		
	Individual Membership	$10.00
	Household Membership	$15.00
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Send remittances, payable to the Maryland Entomological Society, and any address changes to the Treasurer: Edgar J. Cohen, Jr., 5454 Marsh Hawk Way, Columbia, MD 21045-2246, edcohenfam@yahoo.com .

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The MES is a 501(c)(3) non-profit, scientific organization. Meetings are held on the third Friday of October, November, February, March, April and May at 8:00 p.m. in Room 4 of the Biological Sciences Building, University of Maryland Baltimore County (UMBC), or occasionally at another announced site.

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Editor's Note

This issue of ***The Maryland Entomologist*** contains six articles and notes submitted by members of the Maryland Entomological Society.

Chris Sargent, Holly M. Martinson, and Michael J. Raupp document the history and spread of the Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), throughout Maryland. They also provide details of the biology, identification, damage, control and management of this recent exotic invader from Asia.

Edgar A. Cohen, Jr. presents a new Pennsylvania record of a click beetle, *Oestodes tenuicollis* (Randall) (Coleoptera: Elateridae), and reports a previously unpublished record of this beetle from J. N. Knull in 1930. These are the first and second known records for this species in Pennsylvania.

Eugene J. Scarpulla reports on elytral macular variation and melanistic variation in the Sevenspotted Lady Beetle, *Coccinella septempunctata* Linnaeus (Coleoptera: Coccinellidae), from Hart-Miller Island, Baltimore County, Maryland.

Samuel W. Droege and Leo H. Shapiro report on an August survey of wild bees (Hymenoptera: Apoidea) in the northeastern port areas of Baltimore, Maryland. Two new species are documented for the state: *Pseudoanthidium nanum* (Mocsáry) and *Megachile apicalis* Spinola. This is only the second North American record for *P. nanum*.

Leo H. Shapiro and Samuel W. Droege present a survey of the bees (Hymenoptera: Apoidea) of the Dominion Cove Point Liquefied Natural Gas facility and vicinity, Calvert County, Maryland.

John F. Carroll discusses Maryland's range expansion of the Lone Star Tick, *Amblyomma americanum* (Linnaeus) (Acari: Ixodidae) from 1990 to 2011. He reports new and summarized information about the host-seeking seasonality of the larvae, nymphs and adults of this species in the newly colonized areas.

This year's submitted articles and notes demonstrate the excellent studies being conducted, and the impressive discoveries being made, by members of the Maryland Entomological Society. I thank the authors for their submittals that further our knowledge of the insects of Maryland. I express my gratitude to the named and anonymous peer reviewers for their insightful comments that enhance each publication.

Eugene J. Scarpulla
Editor

The Orient Express in Maryland: The Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae)

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ABSTRACT: The Brown Marmorated Stink Bug (BMSB), *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), is an exotic invasive species, native to China, Japan, Korea, and Taiwan, and was first observed in the United States in the mid-1990s. BMSB are occasional pests of soybeans and many fruit trees in Asia. In the United States, they were first recognized as a nuisance pest when they entered homes in large numbers in autumn. Reports soon followed that BMSB were feeding on ornamental plants, home vegetable gardens, and fruit and shade trees in suburban and urban landscapes. Initial fears that BMSB would become a significant agricultural pest in this country were recently confirmed when they began appearing in field, vegetable, orchard, vineyard, and ornamental plantings in many states, where its feeding resulted in millions of dollars of crop losses. Maryland has not been spared invasion by this prolific stink bug, and both producers and homeowners find themselves inundated by a pest they are hard pressed to control. This article summarizes the history, biology, identification and movement of BMSB within Maryland with the hope that this information will enable citizens to deal with this pest in environmentally responsible ways.

INTRODUCTION

The Brown Marmorated Stink Bug (BMSB), *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), an exotic invasive pest, is believed to have entered the United States in the mid-1990s, probably as a stowaway in packing crates originating from eastern Asia. First reports of this pest in America came in the fall of 1996 from home owners in Allentown, Pennsylvania, whose houses were being invaded by hordes of stink bugs. It wasn't until the fall of 2001 that BMSB were positively identified as a new invasive species by E. Richard Hoebeke, Senior Extension Associate at Cornell University and Assistant Curator of the Cornell University Insect Collection (Hoebeke and Carter 2003). Hoebeke found a match for the new stink bug among specimens collected from Harima, Japan, in 1916 (Cornell News 2001).

Since the confirmation of BMSB in Pennsylvania, the insect has been reported in 33 states: from Maine to Mississippi along the eastern seaboard, in central states such as Ohio and Missouri, and as far west as California and Oregon. It is believed that the distribution of BMSB is much wider than is currently documented and that detections will increase with greater public awareness of

this pest. BMSB are strong flyers and opportunistically hitchhike on vehicles, contributing to the rapid spread of this pest. An example of *H. halys*' propensity for hitchhiking was provided by Robert Hammon (2011), Tri River Area Extension Agent at Colorado State University. He reported the following information on ORNAENT, the Ornamental Entomology listserv based at the University. In October 2010, a single BMSB was found in Colorado by an entomologist from New York State who was elk hunting in Rio Blanco County. The entomologist, who was familiar with BMSB, found one in her cabin, which had previously been occupied by visitors from Pennsylvania. The Pennsylvanians had commented to the hunting ranch owners about all of the stink bugs back home, without even realizing they may have been the vehicle of its expansion into the American West.

Our research investigates the spread of this bug across Maryland since its discovery here in 2003, and discusses hypotheses for the pattern of its movement throughout the state. (Unless otherwise cited, general information regarding the biology, identification, impacts and management of BMSB has been adapted from Sargent et al. [2010].)

BIOLOGY AND DESCRIPTION

BMSB belong to the order Hemiptera in the suborder Heteroptera, the true bugs. In the northern part of their native range, they have only one generation each year, but in southern China up to six generations a year have been reported. In the United States, initial studies in New Jersey indicated only one generation per year was possible due to the number of degree days required for bugs to reach sexual maturity (Nielsen and Hamilton 2009). However, research conducted in 2010 at the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) Appalachian Research Station, West Virginia, found that two generations occurred. The number of generations BMSB can produce annually is temperature dependent, and as the pest moves south, more generations per year are expected to occur. BMSB overwinter as adults in protected locations such as in natural rocky outcroppings, beneath logs in forests, and in structures such as houses and other buildings. Adults emerge in the spring over an extended period of time, usually from late March through June, depending on location; however, BMSB sheltering in homes may become active on warm days in late winter. After emerging, adults begin to feed and are very active, dropping off of plants or flying away if disturbed.

BMSB become sexually mature about two weeks after emergence, at which time mating occurs. Egg-laying begins shortly thereafter, and egg masses are laid at approximately one week intervals from mid-May to September. Egg masses are deposited on the underside of host plant leaves in clusters containing 20-30 pale green or white spherical eggs, unlike the typical barrel-shaped eggs other stink bugs lay. Each female can lay about 250 eggs in her lifetime. First instar

nymphs emerge four to five days after the eggs are laid and remain clustered around the egg mass for several days, or even until they molt to the 2nd instar. Nymphs complete five instars, with each stage lasting about one week, more or less, depending upon temperature (Gyeltshen et al. 2005). Nymphs tend to be solitary feeders, but often congregate on leaves, bark, or fruit. Different nymphal instars are often observed together on the same host plant throughout the season. New adults begin to appear in mid to late summer and can complete a second generation in late summer and autumn.

IDENTIFICATION:
BMSB are best identified by examination of the insect themselves:

- Adults are shield-shaped, dark "mottled" brown in color with a darker spot at the posterior where the wings overlap (Figure 1).
- Adults range in size from 13-19 mm (0.5-0.75 inch) long and 6-10 mm (0.25-0.4 inch) in width.
- The outer edges of the abdomen have a pattern of alternating white and dark markings.
- The underside is pale or sometimes rosy, and may have grey or black markings.
- The legs are brown and may have faint white bands.
- **The best field identifying characteristic is a pattern of alternating dark and light bands on the last two antennal segments.**
- Adult BMSB emit a pungent odor when disturbed. Some people find the odor similar to that of coriander.
- Eggs are spherical, about 1.6 x 1.3 mm (0.06 x 0.05 inch), white or pale green in color, found in clusters of 20-30 on the undersides of leaves from mid-May to late summer. (Figure 2)
- BMSB have five nymphal instars (immature developmental stages): all immatures lack fully developed wings and range in size from 1st instar at 2.4 mm (~0.09 inch) to 5th instar at 12 mm (~0.5 inch).
- 1st instars are bright orange to red in color, and usually have a pattern of dark bars down the back and along the margins of the abdomen; head, thorax and legs are black; eyes are dark red; antennae are reddish-black (Figure 2).
- 2nd instars are egg-shaped, mostly black except for a pale abdomen with reddish spots, and have a tick-like appearance; eyes and antennae are reddish/black; the third antennal segment has one whitish band (Figure 3).
- Later instars are pear-shaped; color ranges from brownish/black (3rd instar) to mottled brown with pale spots and alternating white markings along the margins of the abdomen (5th instar); abdomen is whitish with reddish spots; eyes are reddish/black; antennae and legs have alternating black and white bands (Figure 4).

For excellent images of BMSB, see the University of Maryland Home and Garden Information Center website (University of Maryland 2011) at: http://www.hgic.umd.edu/content/brownstinkbug.cfm

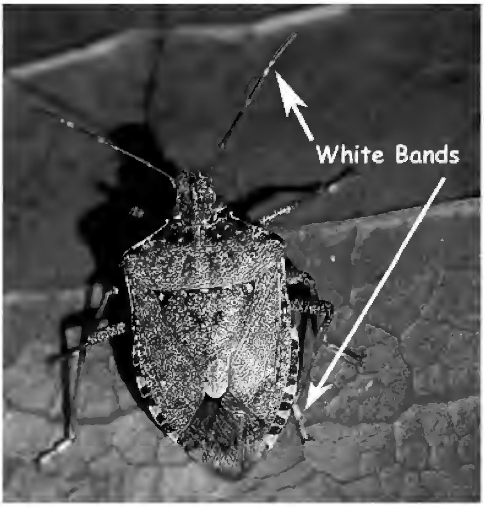

Figure 1. Adult Brown Marmorated Stink Bug (*Halyomorpha halys*). Note the field-identifying characteristic of alternating dark and light bands on the last two antennal segments. This specimen also exhibits light bands on its legs. (Photographed by Michael J. Raupp)

Figure 2. A cluster of Brown Marmorated Stink Bug (*Halyomorpha halys*) eggs and recently emerged 1st instar nymphs. Note that several eggs (pale orange cast) have not yet hatched. (Photographed by Michael J. Raupp)

Figure 3. 1st and 2nd instar nymphs of Brown Marmorated Stink Bug (*Halyomorpha halys*) on an egg mass in which all eggs have hatched. The red and black nymph in the center is a 1st instar; the light red nymph at top has just molted and is a new 2nd instar; the four black nymphs are 2nd instars with typical tick-like appearance. (Photographed by Gary Bernon, United Sates Department of Agriculture [USDA], Animal and Plant Health Inspection Service [APHIS], Bugwood.org)

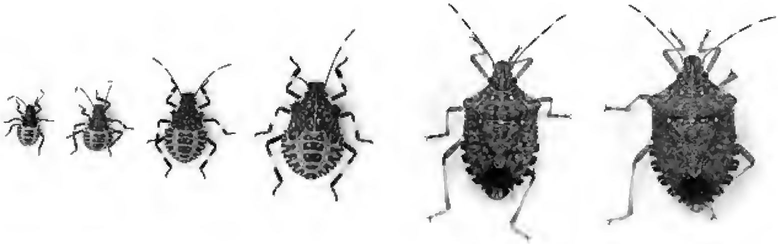

Figure 4. Post-1st instar life stages of Brown Marmorated Stink Bug (*Halyomorpha halys*). Left to right: late 2nd instar nymph (just prior to molt), 3rd instar nymph, 4th instar nymph, 5th instar nymph, adult male and adult female. (Photographed by Wil Hershberger – Nature Images and Sounds)

There are a number of native insects that BMSB may be mistaken for, but in general, BMSB can be distinguished from other stink bugs by their mottled coloration, white bands on the antennae, and the black and white markings along the margin of the abdomen.

- Although the brown mottled color of BMSB is distinctive, there are several native species of brownish stink bugs in the genera *Brochymena* Amyot and Serville and *Euschistus* Dallas that look very similar. The key feature differentiating BMSB from other stink bugs is their dark and light antennal bands.
- Stink bugs in the genus *Brochymena* have dark antennae but lack the alternating dark and light bands, and the margins of the pronotum (the structure behind the head) are strongly "toothed" as compared to the smooth margins of BMSB.
- *Euschistus servus* (Say), the common Brown Stink Bug, has fourth and fifth antennal segments darker than the basal segments, and usually has a pinkish tinge to the ventral surface. The humeral angles of the pronotum are rounded.
- The Spined Soldier Bug, *Podisus maculiventris* (Say) is a beneficial predatory stink bug that could be mistaken for BMSB. It is mottled brown and is associated with some of the same plants as BMSB. The adult has a prominent spine on each "shoulder" which helps distinguish it from other stink bugs.
- Late instar nymphs of leaf-footed bugs (Hemiptera: Coreidae) are often mistaken for BMSB.

For images of bugs that look similar to BMSB, visit the Rutgers New Jersey Agricultural Research Station (NJAES) website (Rutgers 2011c) at: http://njaes.rutgers.edu/stinkbug/similar.asp

The gregarious behavior of BMSB and their tendency to invade buildings in the fall are similar to that of a number of other pests: Multicolored Asian Lady Beetle, Boxelder Bug, Western Conifer-seed Bug, and Cluster Fly.

- The Multicolored Asian Lady Beetle, *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) is oval, convex, and, although the color can vary widely, typically tan to orange to red, often with several black spots on the elytra.
- The Boxelder Bug, *Boisea trivittata* (Say) (Hemiptera: Rhopalidae) is oval in shape (tapering at the head) and has a black body with red markings.
- The Western Conifer-seed Bug, *Leptoglossus occidentalis* Heidemann (Hemiptera: Coreidae) has an elongated body, no banding on its antennae, and a flattened leaf-like area on each hind leg.
- The Cluster Fly, *Pollenia rudis* (Fabricius) (Diptera: Calliphoridae), looks like a large house fly.

(Insect common names are based on the "Common Names of Insects Database" [Entomological Society of America 2011].)

HOST PLANTS:
BMSB are polyphagous and are now known to feed on more than 500 species of plants, including fruit trees, woody and herbaceous ornamental plants, vegetables, grapes, berries, and legumes (Bernon et al. 2004; George C. Hamilton, in litt.). In Asia, BMSB are considered an agricultural pest of a variety of fruit trees, particularly citrus, and of legumes, especially soybeans. They are also known to spread paulownia witches' broom, a phytoplasma disease of princesstree, *Paulownia tomentosa* (Thunb.) Siebold & Zucc. ex Steud. (Scrophulariaceae), in China (Hoebeke 2002). In the United States, adults and all stages of nymphs have been observed feeding on plant parts such as leaves, stems, and fruit, of a wide array of forest and ornamental trees and herbaceous plants, and vegetable, field, and fruit crops. The list of known BMSB hosts continues to grow.

The first BMSB found in Pennsylvania were feeding on ornamental plants, garden crops, fruit and shade trees in suburban areas and urban landscapes. Butterflybush, *Buddleja* L. spp. (Buddlejaceae), and princesstree suffered significant leaf damage; urban peach, *Prunus persica* (L.) Batsch (Rosaceae), and pear, *Pyrus* L. spp. (Rosaceae) were also heavily damaged by BMSB feeding. Homeowners with these favored host plants in their landscapes may be the first to notice BMSB as they spread, and are likely to be helpful in identifying BMSB as they appear in new locations.

(Plant names follow the "The PLANTS Database" of the United States Department of Agriculture, Natural Resources Conservation Service [2011].)

FEEDING DAMAGE:
BMSB adults and nymphs have piercing-sucking mouthparts, the proboscis, which they use to puncture fruit, bark, or leaf surfaces. They inject digestive enzymes which liquefy the plant tissues, and then suck out the liquefied nutrients. This feeding behavior is the primary cause of scarred fruit and damaged leaves, and the resulting injury could make plants more susceptible to secondary infections. Symptoms of BMSB feeding include:

On fruits:
- Small necrotic areas on leaves and fruits.
- Water-soaked lesions and/or distortion (puckering) referred to as "catfacing." Interiors of apples may become corky.
- Pitting, dimples, discoloration and/or depressed areas on mature fruit.
- Surface damage from BMSB feeding on tree fruits such as apples and peaches is similar to that of native stink bug feeding damage; however, internal damage from BMSB feeding may be much deeper and more severe than that of native stink bugs.
- BMSB nymphs have been found feeding on apples and peaches, which is uncommon for native stink bug nymphs.

• BMSB feeding sites may provide entry sites for pathogens that cause necrosis.

On vegetables:
• On tomatoes, damage to ripe fruit appears as whitish-yellow feeding sites referred to as “cloudy spots,” ranging up to 13 mm (0.5 inch) in diameter, with indistinct borders. Spots often join together into a larger area where there have been multiple feedings. Feeding results in whitish corky or spongy areas of tissue just below the skin. On green/pink tomatoes, damage appears as a pinprick surrounded by a light discolored area, which may turn yellow and decay as the tomato ripens.
• On peppers, damage appears as light-colored circular areas, which eventually form slight depressions due to removal and digestion of tissues beneath the fruit surface. The skin over these feeding sites may rupture, resulting in eventual decay of the affected area.
• On okra and bean pods, damage appears as pimples or wart-like growths.
• On sweet corn, BMSB feed on the developing ears, driving their piercing-sucking mouthparts through the husk leaves and into kernels. Removal of liquidized tissue causes the kernels to collapse and show brown discoloration, particularly when the harvested ear is cooked. BMSB feeding on ears right after pollination can cause incomplete kernel fill.

On soybeans:
• BMSB feed on plant stems, foliage, and blooms, creating small brown or black puncture sites. However, they prefer to feed on developing seeds in pods. Injury to young seeds causes deformation and even abortion of the entire pod, whereas older seeds become discolored and shriveled. Germination of injured seeds may be reduced.
• Field infestations of BMSB exhibit strong edge effects, in which BMSB feed mainly along the field margins, delaying plant maturity.

On ornamentals:
• On woody ornamentals in nurseries and landscapes, BMSB tend to feed on the main trunk and branches where they extract sap from the trees. On some trees “wet spots” on the trunks have been noted but no obvious injury has been observed. At this time we are unsure of the long term damage BMSB feeding will cause to woody plants. Researchers at the University of Maryland are studying the damage to ornamentals.
• Stippled areas, roughly circular and 3.2 mm (0.125 inch) wide have been observed on some plants such as princesstree and butterflybush leaves.
• Wilting and death of some herbaceous plants have been reported.

IN BUILDINGS:
BMSB are not known to harm humans or to reproduce inside of houses, but they are considered a nuisance in buildings and emit a pungent odor when crushed or

disturbed. For several weeks beginning in the fall, these pests may seek winter shelter by invading homes. Numbers may range from just a few to tens of thousands. Inside, they may cluster near doors and windowsills, and seem especially attracted to attics for overwintering accommodations. Huge numbers may also congregate on the outsides of buildings. This creates more of a nuisance than actual damage, but can be quite offensive to people.

THE ORIENT EXPRESS: THE SPREAD OF BMSB WITHIN MARYLAND

The arrival and spread of BMSB within Maryland were reported by individuals who were variously curious, desperate, or repulsed. The first verified record of BMSB in Maryland was a specimen collected on 8 October 2003, at a rest area near Hagerstown, Washington County, by Tracy C. Leskey, Research Entomologist for the USDA-ARS. The bug was sent to the USDA-ARS Systematic Entomology Laboratory (SEL) where its identity was confirmed by Thomas J. Henry, Research Entomologist. The Orient Express was beginning its journey across the state!

MATERIALS AND METHODS

Several agencies were involved in documenting reports of BMSB in Maryland. The Maryland Department of Agriculture (MDA) conducted a trapping survey for BMSB in four Maryland counties (Washington, Frederick, Carroll, and Anne Arundel) from late August to late October 2005 (Bean and Rice 2005). The only positive captures were from three trap locations in Washington County. Meanwhile, the Rutgers NJAES had earlier established a website that allowed the public to report sightings of stink bugs suspected to be BMSB. As early as 2004, many Maryland residents began reporting the pest directly to the Rutgers site, rather than to MDA. Eventually, MDA terminated its survey effort, but continues to confirm and record any new county BMSB specimen reports received; the data are entered into the National Agricultural Pest Information System (NAPIS) database. The University of Maryland Extension Home and Garden Information Center (HGIC) began receiving submissions to its pest reporting website about an obnoxious, congregating stink bug in 2005. This website became yet another repository of BMSB reports in Maryland.

We contacted personnel at MDA, the Rutgers NJAES BMSB website, and the Maryland HGIC and requested any data they had for reports of BMSB in Maryland.

- Kimberly A. Rice, Entomologist, and Gaye L. Williams, Entomologist, at the MDA Plant Protection and Weed Management Section, provided BMSB records that cover the period from October 2003, when the first report was received, to December 2010. These records were verified through specimens identified by Gaye L. Williams (MDA), E. Richard Hoebeke (Cornell

University), Thomas J. Henry, Research Entomologist (SEL), or Jeffrey R. Aldrich, Research Entomologist (USDA-ARS).

- George C. Hamilton, Chair, Department of Entomology, Rutgers, The State University of New Jersey, and Coordinator of the Rutgers NJAES BMSB website, provided a data set of over 900 reports received from Maryland citizens from September 2004, when their first report was received, through 30 April 2011. All of these records were verified through submission of a specimen or a photograph and were identified by either Hamilton or Anne L. Nielsen at Rutgers.
- Mary Kay Malinoski, Principal Agent and Regional Extension Specialist, Entomology, at HGIC provided data for stink bug reports received through the HGIC website, searching records from 2000 through April 2011. Although unverified by submission of a specimen, HGIC entomologists feel that the sudden appearance of multiple reports of congregating stink bugs, beginning in 2005 and continuing to the present, are entirely consistent with the arrival of BMSB. Supporting this contention is the fact that no reports of stink bugs were made to the website from 2000 through 2004, prior to the widespread establishment and spread of BMSB throughout the state.

For each data set (MDA, Rutgers NJAES, and HGIC), we determined the first record for each Maryland county. Next, we compiled a list of the first county records from all three data sets, and then examined the dates to determine the earliest county records overall. Using these overall first county records, we were able to construct a time-line of BMSB spread across the state. HGIC and Rutgers also provided data on the total number of reports received per county from 2004 through April 2011. We compiled this data and examined the frequency of residents' reports per county per year, to determine the probable areas of highest concentration of BMSB in the state.

RESULTS

To date, 20 of Maryland's 23 counties, plus the City of Baltimore, have reported the presence of BMSB (Table 1; Figure 5). Of the first records, 14 are specimens verified by either MDA or Rutgers NJAES, and eight come from the unverified HGIC data (HGIC and Rutgers NJAES both list Anne Arundel County in June 2005). In all but one county (Caroline) with first reports to the HGIC website, BMSB infestations were subsequently verified by reports to MDA or Rutgers NJAES. Eight counties and the City of Baltimore had reports of BMSB from all three data sets, although not necessarily in the same year. Only three Eastern Shore counties (Dorchester, Somerset and Worcester) have not yet reported BMSB. In total, the Rutgers NJAES data set contains records for 17 Maryland counties plus the City of Baltimore, the MDA has records from 11 counties and the City of Baltimore, and HGIC reports cover 15 counties and the City of Baltimore (Table 1).

Over time, citizen reports of BMSB increased dramatically, both to Rutgers NJAES and to the HGIC (Figure 6), with consistently more reports to Rutgers NJAES through 2010. Montgomery County had the highest number of records for both HGIC and Rutgers NJAES (Table 2). Although the two data sets reported slightly different rankings of counties, Montgomery, Frederick, and Howard counties were among the top four counties for reporting BMSB in both data sets (Table 2).

County	MDA	Rutgers	HGIC
Allegany	-	2007-09-24	**2006-09**
Anne Arundel	2007-09-30	**2005-06-08**	**2005-06**
City of Baltimore	2006-01-10	2006-02-10	**2005-08**
Baltimore County	2007-06-23	2007-02-17	**2006-08**
Calvert	-	**2008-10-10**	2010-04
Caroline	-	-	**2007-08**
Carroll	2010-10-01	**2007-07-31**	2009-10
Cecil	-	2009-01-27	**2006-04**
Charles	-	**2006-03-20**	2011-02
Dorchester	-	-	-
Frederick	2006-05-31	2007-03-30	**2005-11**
Garrett	**2010-09-08**	-	-
Harford	-	2008-03-05	**2006-02**
Howard	2006-01-27	**2005-09-17**	2008-07
Kent	-	**2010-12-23**	2011-05
Montgomery	2006-01-26	**2005-10-21**	2007-09
Prince George's	**2005-08-15**	2007-08-22	2011-02
Queen Anne's	-	**2009-10-03**	-
St. Mary's	**2010-11-01**	-	-
Somerset	-	-	-
Talbot	2010-09-24	**2006-01-24**	-
Washington	**2003-10-08***	2004-09-23	2005-06
Wicomico	-	**2007-12-01**	-
Worcester	-	-	-

Table 1. First records of the Brown Marmorated Stink Bug (*Halyomorpha halys*) in Maryland counties from each of three data sets: Maryland Department of Agriculture (MDA)[1], Rutgers NJAES[2], and the University of Maryland Home and Garden Information Center (HGIC)[3]. The overall first record for each county is highlighted in bold; the * denotes the first record for the state of Maryland. Dates are given as year-month-day; data from HGIC were recorded by year and month only.

Notes: [1]Verified by Gaye L. Williams, E. Richard Hoebeke, Thomas J. Henry or Jeffrey R. Aldrich; [2]Verified by George C. Hamilton or Anne L. Nielson; [3]Unverified records from homeowner reports.

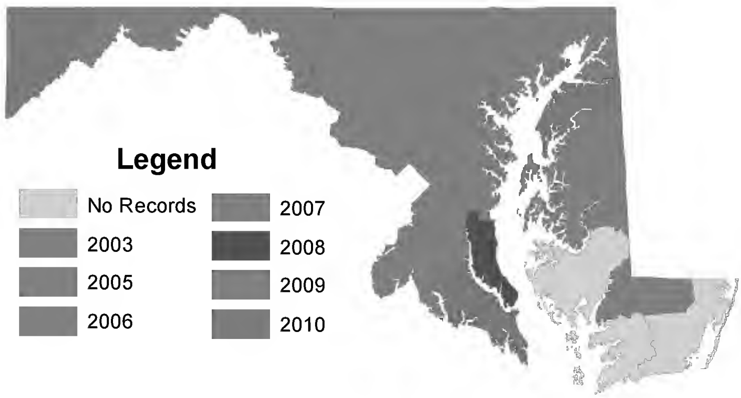

Figure 5. First records of the Brown Marmorated Stink Bug (*Halyomorpha halys*) in Maryland counties and the City of Baltimore. Colors show the first record by year across all three datasets (Table 1). Counties with no records to date are indicated in gray.

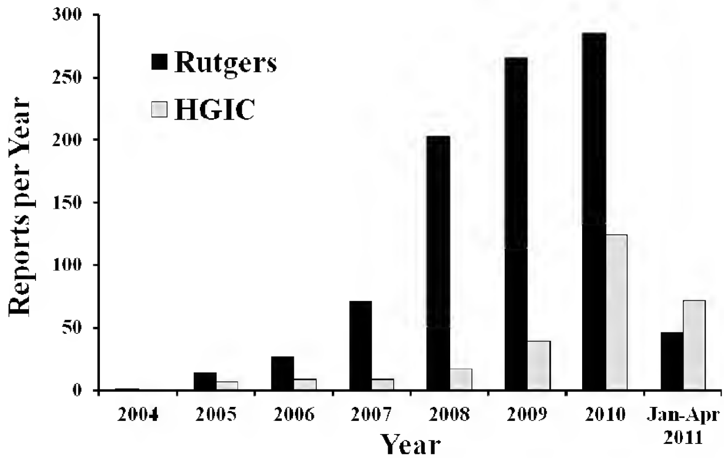

Figure 6. Citizen reports of the Brown Marmorated Stink Bug (*Halyomorpha halys*) to Rutgers NJAES (in black) and the University of Maryland Home and Garden Information Center (HGIC; in gray) from 2004 through 30 April 2011.

County	HGIC	Rutgers	Total
Montgomery	56 (1)	338 (1)	394
Frederick	50 (3)	93 (3)	143
Howard	54 (2)	85 (4)	139
Washington	19 (6)	101 (2)	120
Baltimore County	5 (10)	83 (5)	88
City of Baltimore	28 (4)	46 (7)	74
Anne Arundel	21 (5)	51 (6)	72
Prince George's	6 (9)	41 (8)	47
Carroll	19 (6)	24 (9)	43
Harford	11 (8)	13 (10)	24
Cecil	3 (11)	9 (12)	12
Allegany	1 (13)	10 (11)	11
Charles	1 (13)	6 (13)	7
Kent	-	4 (14)	4
Calvert	1 (13)	2 (16)	3
Queen Anne's	-	3 (15)	3
Caroline	2 (12)	-	2
Talbot	-	2 (16)	2
Wicomico	-	1 (18)	1
Dorchester	-	-	0
Garrett	-	-	0
St. Mary's	-	-	0
Somerset	-	-	0
Worcester	-	-	0
Total	**277**	**818**	**1189**

Table 2. Hot spots of the Brown Marmorated Stink Bug (*Halyomorpha halys*) across Maryland counties. Data are the number of citizen reports to the HGIC and Rutgers NJAES websites by year, from 2004 through 30 April 2011. Each county's rank within the datasets is given in parentheses, and counties are presented by total number of reports, in descending order.

A closer examination of the records reveals an interesting trend. HGIC began keeping records of submissions to their "Send a Question" website (http://www.hgic.umd.edu/faq/sendaquestion.cfm) in 2000, but had no questions regarding stink bugs until 2005. From 2005 to 2007, there were less than ten submissions annually. However, in 2008, the number rose to 17 inquiries; in 2009, that figure more than doubled to 39; and by 2010, awareness was even higher as 124 people submitted questions regarding problems with stink bugs, more than a threefold increase (Figure 6). From 1 January through 30 April, 2011, there have already been 72 reports of BMSB to the HGIC website. The data from Rutgers NJAES follows the same trend, beginning with only one

report in 2004, slowly increasing from 14 in 2005, to 27 in 2006, and then 71 in 2007. The breakout years began in 2008, with 203 reports, and then continued building in 2009 and 2010, with 265 and 285 reports, respectively (Figure 6).

DISCUSSION

In the eight years since it was first detected in Maryland, the Brown Marmorated Stink Bug has spread like a runaway train barreling across the state, generating an exponential increase in the number of citizen reports, and leaving a swath of damage across an ever-widening array of commodities. Now recorded from 20 of 23 counties plus the City of Baltimore, this invasive bug is nearly ubiquitous in the state (Figure 5). The first detection near Hagerstown in 2003 is consistent with a hypothesis of human-assisted movement along a motorway connecting infested Pennsylvania with uninfested Maryland. The fact that the first bug in Maryland was captured at a rest area also supports this notion. BMSB were soon reported in some of Maryland's most populous counties (Montgomery, Prince George's, Frederick, Anne Arundel, Howard, and the City of Baltimore), before spreading over much of the rest of the state. The high number of reports in densely populated counties or those with high commuter populations indicate a pattern of spread that is also consistent with a hypothesis of human-assisted movement, as these counties and the City of Baltimore house major thoroughfares, carrying commuters and travelers to generally infested areas of Pennsylvania and New Jersey. In 2006, BMSB arrived in Cecil County in the northeast corner of the state and began its inexorable descent along the Eastern Shore of Maryland. This rapidly expanding distribution of BMSB in Maryland suggests heightened public recognition as well as human-assisted movement, and has led to increased reporting of BMSB and several new county records in recent years.

Based on the rapid spread of BMSB across the state, it is likely that the three counties currently without reports will soon have BMSB. Dorchester, Somerset and Worcester counties are relatively removed from the initial point of introduction. The lower human population combined with fewer commuters to infested areas likely reduced the initial risk of BMSB infestation in these counties. Although Maryland's Eastern Shore attracts a high volume of vacation traffic in the summer months, this is at a time when BMSB are already out in the landscape feeding, having left their overwintering sites weeks earlier. Human-assisted spread of this pest may be more likely to occur once bugs begin seeking shelter in the fall, infesting recreational vehicles and other motor vehicles. Regardless, BMSB are notable hitchhikers and, combined with growing public awareness of this insect, reports from these counties are likely to come soon.

CONTROL/MANAGEMENT

Because BMSB are widespread, feed on many different plants, and have such devastating economic impacts, various management tools are being developed. Control inside structures is generally through mechanical exclusion and removal. Outdoors, insecticides offer a measure of control, but efforts lead to local suppression rather than eradication of the pest. The BMSB IPM Working Group (Northeastern IPM Center 2011), made up of university, USDA, state Department of Agriculture professionals and other stakeholders, has identified research and extension priorities for this pest. For more details on the working group and the priorities go to: http://www.northeastipm.org/working-groups/bmsb-working-group/. Research is currently being done in the area of Integrated Pest Management (IPM) and biological control.

Mechanical/Physical Management:
BMSB do not harm people, pets, or building materials, but they are decidedly unwelcome houseguests. The best method to prevent BMSB entering homes and buildings is simple exclusion: caulk or seal gaps around windows, doors, utility pipes and other openings; replace or repair damaged screens; screen openings to the outside such as attic and wall vents; and remove or seal window air conditioners in fall to prevent BMSB entering this way (Rutgers 2007). If BMSB enter the home, they can be carefully removed by hand or with a vacuum. When disturbed, BMSB are likely to release an odor, but the odor dissipates. After vacuuming up the bugs, the pests can be eliminated by disposing of the bag or drowning the bugs in soapy water if bagless vacuums are used. Another option to eliminate BMSB from the home is to take advantage of their natural dropping behavior when disturbed. The top can be cut off of a 0.5-gallon (1.9-liter) to 1-gallon (3.8 liter) straight-sided plastic container. Then a hand, a piece of cardboard or a whisk broom is placed above the stink bugs to sweep them down into the container. BMSB will cooperate by dropping when disturbed. Alternatively, the container can be slid up a wall, window, or drapes to make bugs drop into the container. This container can be attached to a pole or broom handle to reach high locations.

Several researchers are investigating the use of traps to monitor stink bug activity. These traps rely on intensities and wavelengths of light that attract stink bugs. BMSB are also attracted to pheromones of related species; these too are used to attract stink bugs to traps. The search is underway to find pheromones unique to BMSB that can be used in trapping devices. One management tactic called “attract and kill” combines a baited trap to attract stink bugs and a killing agent, such as a conventional or biopesticide strip, that kills bugs that enter the trap. While several traps have been shown to attract and capture stink bugs, their efficacy in reducing damage caused by BMSB has yet to be demonstrated.

Biological Control:
BMSB pose a significant risk to agriculture. Consequently, USDA-ARS, University of Maryland and other scientists began studying biological control as an option for IPM programs. Several native parasites and predators, including *Telenomus podisi* Ashmead (Hymenoptera: Scelionidae), a generalist stink bug parasitoid, have been reported to attack this new host. However, the best hope may rest with the importation of parasitic wasps that attack BMSB throughout their home range in Asia. Currently, the USDA-ARS Beneficial Insects Introduction Research Unit in Newark, DE has four species of *Trissolcus* (Hymenoptera: Scelionidae) wasps (USDA-ARS 2011) in quarantine and under evaluation for their potential release (Murray 2011). These wasps often provide high levels of control of BMSB in Asia. Other scientists are evaluating strains of formulated microbial insecticides that could be used against BMSB. Indigenous and imported natural enemies may be our best hope for a sustainable solution to the BMSB invasion and evaluation of many kinds of biological control agents is currently underway.

Chemical Control:
Indoors: There are no pesticides specifically labeled for indoor use against BMSB. Homeowners are strongly encouraged to weigh the benefits of chemical use against a nuisance pest versus the risks to human and pet health. Because BMSB enter and reside in homes over a long period of time and then move about within the house, chemical control would be difficult to achieve and is not recommended.

Outside buildings: There are some synthetic pyrethroid insecticides available to licensed commercial pesticide applicators (i.e., deltamethrin, cyfluthrin, lambda-cyhalothrin, cypermethrin, sumithrin or tralomethrin) that may be applied to building exteriors just as BMSB begin congregating in the fall. There are also several insecticide products available to homeowners that are labeled for application to the exterior of structures. Insecticides should be chosen that are labeled for application around window sills and door thresholds, which are points of entry for this insect. Insecticides should not be applied to the house foundation or to mulch.

Pesticides generally provide only temporary reductions in stink bug populations and are unlikely to provide sustainable control. See Mechanical/Physical Management section above for optimum control measures.

Home gardens: Current research at the University of Maryland College Park will soon provide recommendations on effective home garden pesticides for controlling BMSB on vegetables. Several products are labeled for use in home vegetable gardens, but their efficacies against BMSB are currently unknown.

Nurseries and landscapes: Pyrethrin is labeled for stink bug control on ornamentals but has not been evaluated specifically for BMSB, therefore the level of control for BMSB is not known. Several products used by growers and certified pesticide applicators will likely be highly efficacious in controlling stink bugs on ornamental plants.

Fruit and vegetables: Research is currently underway to evaluate efficacies of various insecticides for BMSB control, including new products and those already registered for other stink bug species. Pyrethroids such as lambda-cyhalothrin, cyfluthrin and zeta-cypermethrin, and acephate, an organophosphate, are effective and commonly used to control stink bugs. Several systemic neonicotinoids, dinotefuran, acetamiprid and clothianadin, show moderate to good levels of control but require further testing.

With all insecticides, users must carefully read and follow label directions. If stink bugs are not listed as target pests, the product may not be effective. Local Cooperative Extension Service offices should be contacted for current pesticide recommendations.

Rutgers NJAES is monitoring the regional spread of BMSB and is asking people to report suspected sightings of BMSB via a secure on-line form (Rutgers 2011b) at: https://njaes.rutgers.edu/stinkbug/report.asp.

To learn more about BMSB, please visit the Rutgers (2011a) website at: http://njaes.rutgers.edu/stinkbug/ and the University of Maryland website (Sargent et al. 2010) at:
http://pestthreats.umd.edu/content/documents/BMSBBulletin1_10-2010_000.pdf

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How to Report a Possible Sighting/Infestation

Sightings Within Maryland:
University of Maryland Home and Garden Information Center
http://www.hgic.umd.edu/
Within Maryland: 1-800-342-2507
Outside Maryland: 1-410-531-1757

Rutgers New Jersey Agricultural Experiment Station
https://njaes.rutgers.edu/stinkbug/report.asp

Sightings Outside of Maryland:
USDA-Animal and Plant Health Inspection Service (APHIS)
http://www.aphis.usda.gov/services/report_pest_disease/report_pest_disease.shtml

Rutgers New Jersey Agricultural Experiment Station
https://njaes.rutgers.edu/stinkbug/report.asp

First and Second State Records of a Click Beetle, *Oestodes tenuicollis* (Randall) (Coleoptera: Elateridae: Lissominae: Oestodini) from Tioga County and Sullivan County, Pennsylvania

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For the last twenty years, I have been conscientiously surveying a well-known collecting territory in north central Pennsylvania that had been frequented by longtime Tioga County resident collector George Patterson many years ago (Clench 1979). The spot in question originally was suggested to me by Austin P. Platt, Professor Emeritus in the Department of Biological Sciences at the University of Maryland, Baltimore County, in Catonsville, Maryland. Originally I had been interested in a location where I would reliably be able to collect a series of the White Admiral butterfly, *Limenitis arthemis arthemis* (Drury) (Lepidoptera: Nymphalidae), the area being the most southerly zone where I could do so. In the early years (the 1980s), I was also pleasantly surprised to find a small population of Milbert's Tortoiseshell, *Aglais milberti* (Godart) (Lepidoptera: Nymphalidae), a butterfly that I had not seen since my childhood days at a camp in upstate Pennsylvania.

The present saga concerns a surprising find of a new county record (at least previously undocumented) of an elaterid beetle from this same location on 15 July 2010. The beetle was an incidental find that happened to land on the windshield inside my car as my wife and I were traveling along Lick Run Road near Lick Run, in Gaines Township, Tioga County, Pennsylvania. I was initially rather puzzled when I examined this beetle with my stereo microscope, as the anterior lobe of the prosternum was truncated (Figure 1). In almost every other elaterid found in the United States, this lobe is prominent, but in this case, it was absent. This is reminiscent of the family Eucnemidae Eschscholtz (false click beetles), which, in the old days of geologist/entomologist Willis S. Blatchley (1859-1940) and others, would have been placed as a subfamily of the family Elateridae Leach (click beetles). However, the head character was consistent with that of an elaterid rather than a eucnemid, for in the latter case, the head is always deflexed (abruptly bent downward and resting against the prosternum in repose). In fact, in elaterids the head may point either forward (prognathous) or downward (hypognathous) depending upon the species of beetle, but it will never be as deflexed as it would be in the eucnemids. Furthermore, the Elateridae tend to have their antennae closer to their eyes than the Eucnemidae. Thus I was enlightened when I ran through Paul J. Johnson's key (2002) to the family Elateridae in the relatively recent work, *American Beetles* (Arnett et al. 2002). The beetle keyed to *Oestodes tenuicollis* (Randall) (Figure 2; Figure 3).

Figure 1. ***Oestodes tenuicollis.*** View of prosternum showing the key generic character for the genus, namely, the truncated anterior prosternal lobe. Lick Run Road, Tioga County, Pennsylvania. 15 July 2010. (Photograph courtesy of Paul J. Johnson).

Figure 2. ***Oestodes tenuicollis*, female habitus.** Length 10 mm (0.4 inch). Note the short hind angles at the base of the pronotum. This character, not mentioned in the usual keys, may be a useful one to observe (Johnson in litt.). Lick Run Road, Tioga County, Pennsylvania. 15 July 2010. (Photograph courtesy of Paul J. Johnson).

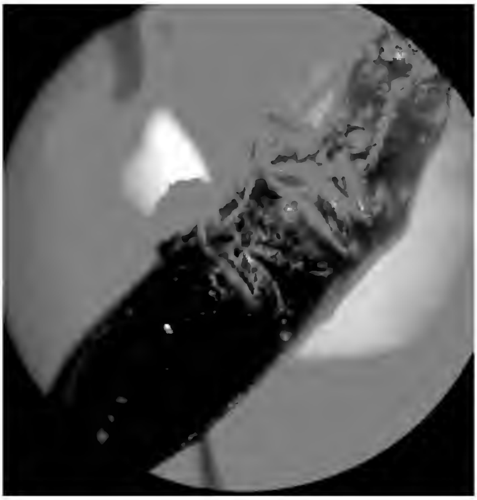

Figure 3. ***Oestodes tenuicollis.*** Ventral aspect showing the serrate antennae. Lick Run Road, Tioga County, Pennsylvania. 15 July 2010.

The given distribution was from Maine to New York; Pennsylvania was not mentioned (Johnson 2002). This species is a diurnal click beetle, thus not collected at night lights.

Paul J. Johnson, Professor of Entomology and Curator of the Severin-McDaniel Insect Research Collection in the Department of Plant Science at South Dakota State University, Brookings, South Dakota, confirmed my identification and recommended that I publish this discovery. He also encouraged me to check for any possible regional records that may not have been officially published. I checked a number of museum records, in particular those of the Academy of Natural Sciences, Philadelphia, Pennsylvania; the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania; the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; and the Cornell University Insect Collection, Ithaca, New York. Indeed, there were no documented records from Pennsylvania at any of these renowned museums.

The one museum having any Pennsylvania records turned out to be the Smithsonian Institution's National Museum of Natural History in Washington, DC. The museum possessed three historic, apparently unpublished records, of this beetle in the Merton C. Lane Collection. The specimens were dated 17 July 1930 and were collected by J. N. Knull in Forksville, Sullivan County, Pennsylvania. Sullivan County is located southeast of Tioga County. Since the Knull specimens also represent previously unreported records, I report them

here along with my specimen as documenting the first and second state records for *O. tenuicollis* from locations in two Pennsylvania counties. There is an 80-year gap between these two collection dates.

In *The Beetles of Northeastern North America* (Downie and Arnett 1996), the distribution of *O. tenuicollis* is given as Quebec, Ontario, Maine, New Hampshire, Vermont, Massachusetts and New York. Thus it is a beetle of northern climes. It apparently had not been reported by Downie and Arnett (1996) as being found in Pennsylvania (no published records from that state). It might be interesting to see whether or not this same species could be found in the Appalachian Mountains of western Maryland.

Johnson (2002) stated that there are two North American species of this genus, there also being a western species, *Oestodes puncticollis* Horn, found in Manitoba and North Dakota.

The Tioga County *O. tenuicollis* specimen has been placed in the Severin-McDaniel Insect Research Collection at South Dakota State University.

The reader is encouraged to visit north central Pennsylvania for other orders of insects as well. For example, I have found several interesting species of Diptera and Trichoptera to be present in this region.

ACKNOWLEDGEMENTS

I wish to thank Paul J. Johnson, of South Dakota State University, who confirmed my identification of this beetle, contributed the first and second photographs, and reviewed a draft of this note, considerably enhancing the final presentation. I also thank Natalia J. Vandenberg, Entomologist, and Elisabeth P. Roberts, Museum Specialist, at the United States Department of Agriculture, Agricultural Research Service, Systematic Entomology Laboratory, Washington, DC for their assistance locating the Knull specimens of *O. tenuicollis*.

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Elytral Macular Variation and Melanistic Variation in *Coccinella septempunctata* Linnaeus (Coleoptera: Coccinellidae), Sevenspotted Lady Beetle, from Hart-Miller Island, Baltimore County, Maryland

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Hart-Miller Island is located in Baltimore County, Maryland, off the mouth of Back River in the northern Chesapeake Bay. The island is made up of two sections: Hart-Miller Island State Park and the Hart-Miller Island Dredged Material Containment Facility (Peters 2008).

From 2005 through 2009, seven species of Coccinellidae (Coleoptera) have been observed on Hart-Miller Island (Table 1).

Subfamily	Species	Common Name
Chilocorinae	*Chilocorus stigma* (Say)	Twicestabbed Lady Beetle
Coccinellinae	*Naemia seriata* (Melsheimer)	Seaside Lady Beetle
Coccinellinae	*Coleomegilla maculata* (De Geer)	Spotted Lady Beetle
Coccinellinae	*Hippodamia convergens* Guérin-Méneville	Convergent Lady Beetle
Coccinellinae	*Coccinella septempunctata* Linnaeus	Sevenspotted Lady Beetle
Coccinellinae	*Harmonia axyridis* (Pallas)	Multicolored Asian Lady Beetle
Epilachninae	*Epilachna varivestis* Mulsant	Mexican Bean Beetle

Table 1. Coccinellid species observed on Hart-Miller Island, 2005-2009 (Scarpulla 2008 and unpublished data). Subfamily affinities are based on Vandenberg (2002). Common names are based on the "Common Names of Insects Database" (Entomological Society of America 2011) except for Seaside Lady Beetle (BugGuide 2011b) and Spotted Lady Beetle (BugGuide 2011a).

Harmonia axyridis was the most frequently observed coccinellid on the island (22 days), followed by *C. septempunctata* (13 days). The other five species were observed on only 1 to 3 days each. *Coccinella septempunctata* was observed from 21 March through 11 October (Table 2).

On 7 July 2007, an aberrant *C. septempunctata* was observed and captured on Hart-Miller Island. The lady beetle was found on an ornamental plant near the Hart-Miller Island Dredged Material Containment Facility administration building.

Observation Date	Number Observed	Elytral Pattern
21 March (2009)	1	Typical
16 June (2007)	present	Typical
23 June (2007)	3	Typical
30 June (2007)	1	Typical
07 July (2007)	4	3 typical, 1 atypical
08 July (2006)	1	Typical
11 August (2007)	20	18 typical, 2 atypical
18 August (2007)	10	Typical
08 September (2007)	7	Typical
08 September (2008)	1	Typical
15 September (2007)	1	Typical
19 September (2009)	1	Typical
11 October (2008)	2	Typical
Total	**52+**	**49+ typical, 3 atypical**

Table 2. Temporal distribution of *Coccinella septempunctata* observations by month and day including elytral patterns.

Gordon (1985) provides the following diagnosis for *C. septempunctata*:

> "Length 6.50 to 7.80 mm. Head black with 2 well separated pale spots; pronotum with anterior margin black at middle with ventral pale spot small, extending posteriorly ⅓ as far as dorsal spot; elytron with 3 black spots in addition to scutellar spot."

Species identification of this beetle in the field was problematic since the individual appeared to be a Sevenspotted Lady Beetle (Figure 1), but only five elytral maculae were apparent (Figure 2). On this individual, the two apical maculae were missing from the elytra. The lady beetle was female and released eggs while in confinement. The beetle was photographed and then released.

On 11 August 2007, two additional aberrant *C. septempunctata* were observed on Hart-Miller Island. One had the posterior portion of both elytra blackish (Figure 3); the other had the central portion of both elytra blackish (Figure 4). The demarcation between the melanistic portions and the non-melanistic portions was not sharp, but instead showed a gradation between the two areas. Neither of the two specimens was photographed or collected.

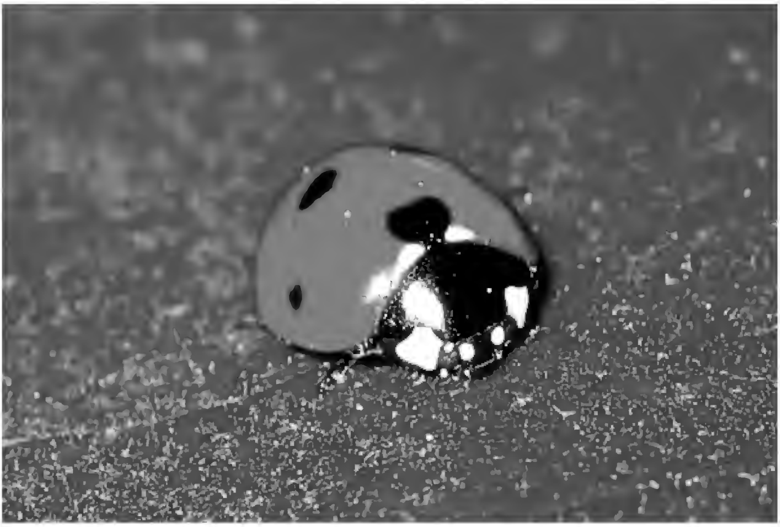

Figure 1. ***Coccinella septempunctata*** **with missing apical maculae.** Frontal view showing typical species characters. Hart-Miller Island, Baltimore County, Maryland, 7 July 2007.

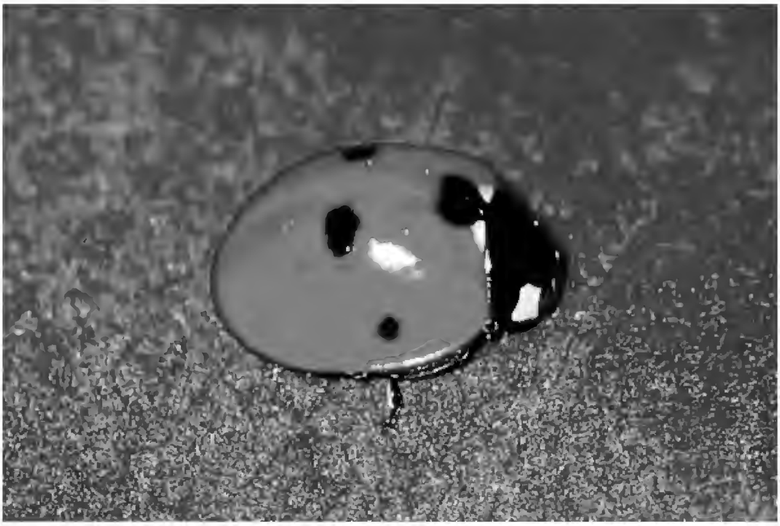

Figure 2. ***Coccinella septempunctata*** **with missing apical maculae.** Lateral view. Female. Length ~6.4 mm (~0.25 inch). Hart-Miller Island, Baltimore County, Maryland, 7 July 2007.

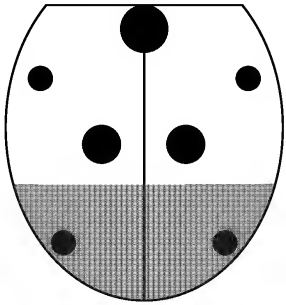

Figure 3. Depiction of *Coccinella septempunctata* with the posterior portion of both elytra melanistic. Hart-Miller Island, Baltimore County, Maryland, 11 August 2007.

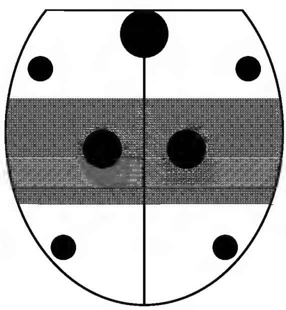

Figure 4. Depiction of *Coccinella septempunctata* with the central portion of both elytra melanistic. Hart-Miller Island, Baltimore County, Maryland, 11 August 2007.

Hesler et al. (2010) documented variation in elytral patterns in 567 North American and 107 Palearctic *C. septempunctata* specimens and 382 North American digital submissions. They found 20 *C. septempunctata* with symmetrical variations. These included 2 specimens that lacked apical maculae and 7 specimens and 11 images that possessed paired humeral markings. Humeral markings were typically lighter than maculae. Additionally, Hesler et al. reported 20 specimens and 16 digital images with asymmetrical elytral markings such as dark, circular pock marks and irregular fuscous markings. They did not report finding any melanistic specimens or images.

DISCUSSION

Elytral Macular Variation

The Hart-Miller Island *C. septempunctata* image that lacked apical elytral maculae is the third known individual to be documented in North America. The previous two specimens were collected in South Dakota, one from Custer County on 6 July 2008, and one from Brookings County on 29 June 2009 (Hesler et al. 2010). Additionally, Natalia J. Vandenberg (in litt.) has encountered an occasional *C. septempunctata* with missing maculae when sorting through large sweep samples. Mabbott (2006) states that *C. septempunctata* has a very constant pattern of elytral maculae, with spot numbers only rarely varying between 0 and 9.

Melanistic Variation

The two Hart-Miller Island *C. septempunctata* melanistic variants are the first known reports for North America. Vandenberg (in litt.) suggests that perhaps these aberrations may represent developmental abnormalities as shown in Mabbott (2006). Mabbott states that patchy blackening of the elytra is a common aberration in *C. septempunctata*.

Asymmetrical Elytral Markings

No asymmetrical elytral markings were observed in the 52+ *C. septempunctata*.

Paired Humeral Markings

It is unknown whether paired humeral markings were present on any of the 52+ *C. septempunctata* since this variation was not looked for in the field.

These variations, as well as other elytral variations, should continue to be documented to determine the extent of variation in *C. septempunctata*, as well as other coccinellids, in North America.

ACKNOWLEDGEMENTS

I wish to thank Natalia J. Vandenberg and Steven W. Lingafelter, Entomologists at the United States Department of Agriculture, Agricultural Research Service, Systematic Entomology Laboratory, Washington, DC, for reviewing a draft of this note and providing helpful comments.

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An August Survey of Wild Bees (Hymenoptera: Apoidea) in the Northeastern Port Areas of Baltimore, Maryland and the Second North American Record of *Pseudoanthidium nanum* (Mocsáry)

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ABSTRACT: In August 2010, a survey of wild bees was undertaken in the northeastern port areas of Baltimore, Maryland. Bees were sampled with nets and colored bowl traps. A total of 507 bees and 49 species were captured; 201 were netted (35 species, 0.72 bees per minute) and 306 trapped (31 species, 1.55 bees per trap). Eleven species (71 individuals) were not native to North America. This study documents a relatively rich fauna in an industrial matrix and one very high in non-native species not regularly found in the rest of the state. *Pseudoanthidium nanum* (Mocsáry) and *Megachile apicalis* Spinola are recorded for the first time in the Maryland. This is only the second record for *P. nanum* in North America.

INTRODUCTION

Bees (Hymenoptera: Apoidea) are found in all habitats in the state of Maryland, readily occupying urban areas where they can be found nesting in a variety of substrates in settings such as residential lots, flower planters, green roofs, medians, and schoolyards. In these areas, bees can be found foraging on an abundance of planted ornamentals, flowering weeds, scattered native plants and residual natural habitats.

Bees in urban environments form a subset of the larger landscape's bee communities (Matteson et al. 2008). Urban bee species tend to be generalists, where females gather pollen from a variety of plants; however specialist bees such as *Ptilothrix bombiformis* (Cresson) on mallows (Malvaceae), *Melitoma taurea* (Say) on bindweeds (Convolvulaceae), and *Peponapis pruinosa* (Say) on cucurbits (Cucurbitaceae) readily colonize sites where their pollen hosts become established. Our observations from the Mid-Atlantic region indicate that bees in urban areas can occur in relatively high abundance, but no papers outside of the New York, NY area have been published on urban bees in this region (Matteson et al. 2008).

The Port of Baltimore is the twenty-third largest port in the United States ranked on foreign trade imports (American Association of Port Authorities 2009) and

we chose to do two surveys in the northeastern regions of the port because of the diversity of urban landforms present (e.g., abandoned piers, newly bulldozed building sites, cemeteries, the many abandoned lots surrounding the former Bethlehem Steel plant at Sparrows Point [owned by Severstal Sparrows Point during the survey; currently owned by RG Steel, LLC], a network of rail lines, and many industrial and residential plantings). Additionally, the possibility of detecting newly arrived non-native species of bees seemed high here due to the proximity of the many cargo containers from Europe and the abundance of non-native weeds.

METHODS

Sixteen sites in the northeastern port areas were visited twice: once by Droege from 1330 hours to 1630 hours on 8 August 2010 and once by Droege and Shapiro from 0740 hours to 1650 hours on 28 August 2010 (Figure 1). Only netting was employed during the first visit, while both bowl traps and netting were employed during the second. Table 1 documents the site locations, amount of time spent netting or using bowl traps, the number of bowls retaining water throughout the trapping period, and the number of bees captured by each method.

Netting sites were chosen based on the presence of abundant blooming plants which we perceived to be attractive to bees. The following were the most commonly targeted plant species for netting: *Centaurea* L. spp. (Asteraceae), knapweed; *Cirsium vulgare* (Savi) Ten. (Asteraceae), bull thistle; *Dipsacus fullonum* L. (Dipsacaceae), Fuller's teasel; *Erigeron* L. spp. (Asteraceae), fleabane, *Eupatorium* L. spp. (Asteraceae), thoroughwort; *Helianthus annuus* L. (Asteraceae), common sunflower; *Melilotus alba* Medikus, orth. var. (Fabaceae), white sweetclover; *Melilotus officinalis* (L.) Lam. (Fabaceae), yellow sweetclover; and *Solidago* L. spp. (Asteraceae), goldenrod.

The locations to be investigated were determined 1) by examining maps, 2) by our experience in the region, and 3) opportunistically as we drove around the area. Nets used were a Rose Entomology 45.7-centimeter (18-inch) diameter model (Droege) and a BioQuip Products 38.1-centimeter (15-inch) diameter model (Shapiro). Bowls used were 96.1-milliliter (3.25-ounce) "Solo® soufflé portion cups". At each site, 30 bowls were deployed (10 white, 10 fluorescent blue, and 10 fluorescent yellow) in alternating colors and spaced 5 meters (16.4 feet) apart in open habitats (often lawns or mown areas). Fluorescent colors were created using a white latex base paint and fluorescent blue and yellow pigments (Droege 2010). The bowls were partially filled with slightly soapy water (Ultra Dawn® blue dishwashing liquid).

The bowl-trapped or netted bees were stored in 70% ethyl alcohol and then washed, dried, pinned, labeled, and identified in the Droege laboratory.

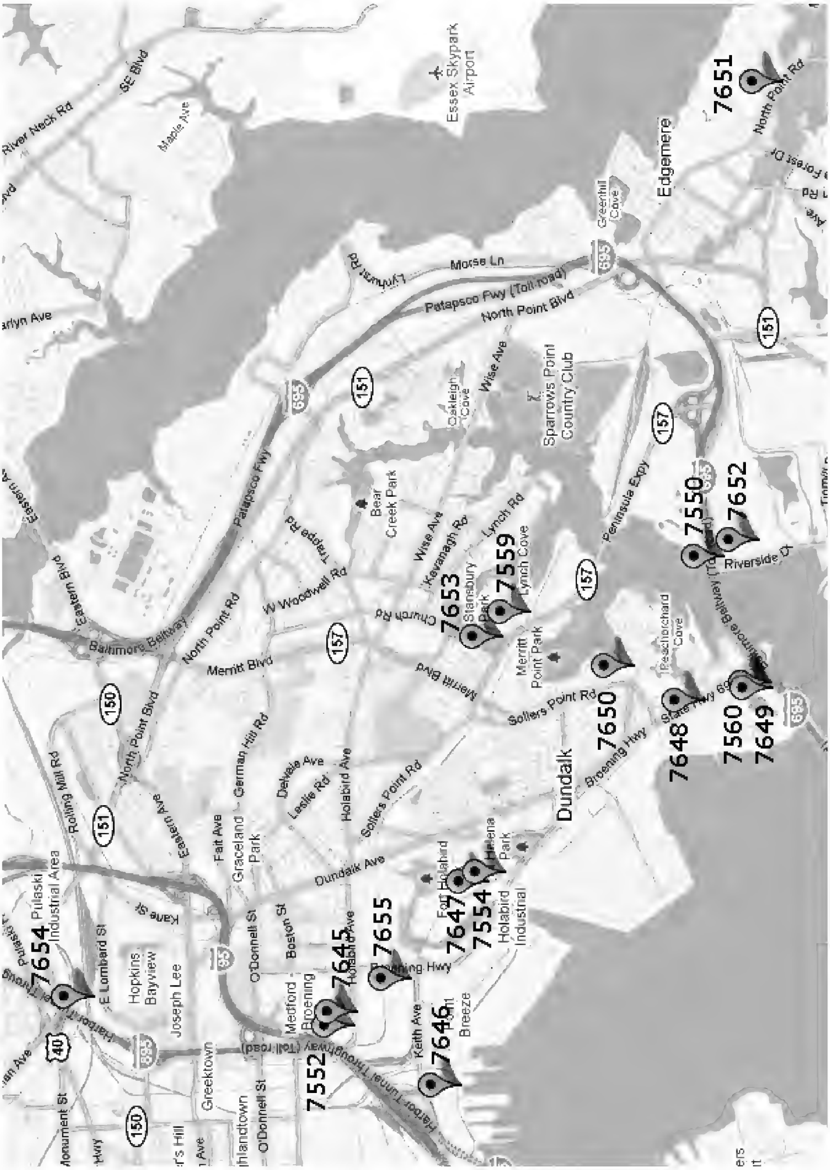

Figure 1. Sampling site locations in Northeastern port areas of Baltimore, Maryland, August 2010. (Map adapted from Google maps [2011].)

Site Number	Latitude	Longitude	Date	Number of Collectors	Minutes Netting	Number of Bees Netted	Bees Netted/ Minute/ Collector	Number of Bowls	Bowl Start Time	Bowl End Time	Number of Bees Bowl-Trapped	Bees Per Bowl	Total Bees
7550	39.2363	-76.4923	8 Aug	1	30	2	0.07						2
7552	39.2717	-76.5505	8 Aug	1	20	28	1.4						28
7554	39.2573	-76.5314	8 Aug	1	40	13	0.33						13
7559	39.2548	-76.4991	8 Aug	1	25	22	0.88						22
7560	39.2316	-76.5086	8 Aug	1	15	5	0.33						5
7645	39.2715	-76.5488	28 Aug					29	740	1525	23	0.79	23
7646	39.2615	-76.5579	28 Aug					29	745	1555	40	1.38	40
7647	39.2589	-76.5326	28 Aug					29	805	1537	22	0.76	22
7648	39.2381	-76.5101	28 Aug					25	820	1610	80	3.2	80
7649	39.2317	-76.5080	28 Aug					30	830	1620	21	0.7	21
7650	39.2449	-76.5059	28 Aug					30	850	1630	106	3.53	106
7651	39.2307	-76.4334	28 Aug					25	930	1650	14	0.56	14
7652	39.2329	-76.4902	28 Aug	2	60	39	0.33						39
7653	39.2575	-76.5023	28 Aug	2	10	5	0.25						5
7654	39.2967	-76.5469	28 Aug	2	60	73	0.61						73
7655	39.2663	-76.5447	28 Aug	2	20	14	0.35						14
Totals					280	201		197			306		507

Table 1. Sampling site locations, numbers of bees captured, and effort expended to capture bees. Northeastern port areas of Baltimore, Maryland, August 2010.

Pseudoanthidium nanum (Mocsáry) specimens were deposited in the United States Department of Agriculture (USDA), Agricultural Research Service (ARS) Pollinating Insects Laboratory in Logan, Utah. Some of the other uncommon species were deposited in the U.S. National Entomological Collection at the Smithsonian Institution's National Museum of Natural History.

RESULTS

The capture results by species and capture technique, subdivided by date, are presented in Table 2. A total of 507 bees were captured representing at least 49 species. Note that the *Lasioglossum viridatum* (Lovell) group may include more than one species (Gibbs 2010) and that "*Lasioglossum* species #2" is our informal name for a species soon to be described by Jason Gibbs (in litt.), Postdoctoral Researcher, Danforth Lab, Cornell University, Ithaca, New York. (Note: "*Lasioglossum* species #1" occurs in Shapiro and Droege [2011] and is another species soon to be described by Gibbs [in litt.].) Of those captures, 70 were netted during the first trip, 131 netted on the second (0.72 bees per minute across all captures) and 306 captured in bowl traps (1.55 bees per bowl across all bowls).

Thirty-four species were netted and 31 captured in bowl traps. Thirty-one species were only caught by one of the two techniques (17 by net only and 14 only in bowls) and 17 species were caught by both methods. Species in the genus *Hylaeus* Fabricius were only caught while netting and those in *Megachile* Latreille primarily so. *Lasioglossum* Curtis specimens were mainly collected with bowl traps. Bee captures per bowl varied among the seven sites from a low of 0.56 (in an area of thick tall grass with few blooming plants) to a high of 3.53 (in a mown area under a transmission line) (mean across sites = 1.56, SD = 1.26). Bee captures per minute per collector varied from 0.07 to 1.40 (mean across sites = 0.50, SD = 0.41).

Of the 49 species captured (excluding unidentified *Lasioglossum* species and unidentified *Lasioglossum* males from the species total), 11 (22%) were not native to North America. These non-native specimens accounted for 71 of the 507 total individuals (14%) captured. Four individuals (1%) of two species (4%) of nest parasites were collected (*Coelioxys coturnix* Pérez and *C. sayi* Robertson). Four species (8%) with 9 individuals (2%) have relatively narrow pollen preferences: *Ptilothrix bombiformis* – mallows (Malvaceae); *Melissodes trinodis* Robertson – *Helianthus* (Asteraceae); *M. agilis* Cresson – *Helianthus*; *Megachile apicalis* Spinola – *Centaurea* (Asteraceae) and all of these plants were present and blooming in the region during the survey. Others show preferences for relatively large groups of plants (e.g., *Megachile concinna* Smith and *M. rotundata* [Fabricius] for legumes [Fabaceae] and *Hylaeus* species for umbellifers [Apiaceae]); however the majority of species had very broad preferences across many groups of plants.

Family	Species	8 Aug Netting	28 Aug Netting	28 Aug Bowl	Total	Regional
Colletidae	*Hylaeus affinis* (Smith)/*modestus* Say	1			1	101
	Hylaeus leptocephalus (Morawitz)*	1	1		2	
	Hylaeus mesillae (Cockerell)	2	2		4	6
	Hylaeus punctatus (Brullé)*	2			2	
Andrenidae	*Calliopsis andreniformis* Smith			10	10	177
Halictidae	*Agapostemon virescens* (Fabricius)			1	1	406
	Augochlora pura (Say)	2		5	7	187
	Augochlorella aurata (Smith)	1	2	15	18	407
	Halictus confusus Smith			8	8	150
	Halictus ligatus Say/*poeyi* Lepeletier			5	5	253
	Halictus tectus Radoszkowski*	9	1	3	13	1
	Lasioglossum bruneri (Crawford)		1	6	7	344
	Lasioglossum callidum (Sandhouse)			19	19	124
	Lasioglossum coreopsis (Robertson)			6	6	38
	Lasioglossum illinoense (Robertson)			4	4	201
	Lasioglossum imitatum (Smith)	3		4	7	45
	Lasioglossum mitchelli Gibbs	1		16	17	*a*
	Lasioglossum oblongum (Lovell)			1	1	39
	Lasioglossum pilosum (Smith)			69	69	759
	Lasioglossum tegulare (Robertson)		1	35	36	134
	Lasioglossum versatum (Robertson)	1		6	7	840
	Lasioglossum viridatum (Lovell) group			8	8	*a*
	Lasioglossum zephyrum (Smith)			2	2	5
	Lasioglossum species #2			2	2	*a*
	Lasioglossum Curtis unidentified ♂ sp.			6	6	22
	Lasioglossum Curtis unidentified sp.			3	3	*b*
Megachilidae	*Anthidium manicatum* (Linnaeus)*	2			2	
	Anthidium oblongatum (Illiger)*		1	4	5	39
	Coelioxys coturnix Pérez*‡		1		1	
	Coelioxys sayi Robertson‡		3		3	15
	Megachile apicalis Spinola*	2			2	
	Megachile campanulae (Robertson)		1		1	4
	Megachile concinna Smith*	5	14		19	
	Megachile exilis Cresson	1	5		6	7
	Megachile mendica Cresson	8	15		23	80
	Megachile petulans Cresson		1		1	1
	Megachile rotundata (Fabricius)*	1			1	12
	Megachile texana Cresson	3	5	2	10	
	Pseudoanthidium nanum (Mocsáry)*		3		3	
Apidae	*Apis mellifera* Linnaeus*	13	7	1	21	87
	Bombus fervidus (Fabricius)	2		1	3	20
	Bombus impatiens Cresson	8	20	1	29	78
	Ceratina calcarata Robertson		36	29	65	111
	Ceratina dupla Say		1	7	8	88
	Ceratina strenua Smith		2	18	20	335
	Melissodes agilis Cresson		2		2	
	Melissodes near *agilis* Cresson		2		2	*b*
	Melissodes bimaculata (Lepeletier)			7	7	2
	Melissodes trinodis Robertson		1	1	2	
	Ptilothrix bombiformis (Cresson)			1	1	24
	Xylocopa virginica (Linnaeus)	2	3		5	16
	Total Number of Bees	70	131	306	507	5158
	Number of Species	21	25	31	49	35

Table 2. Numbers of bees captured using insect nets and bowl traps. Northeastern port areas of Baltimore, Maryland, August 2010. Included for comparison are bees captured by Droege from 2001 – 2010 in Anne Arundel, Baltimore, Carroll, Harford, Howard, and Prince George's Counties (= "Regional") using both nets and bowl traps. (Only Regional species that were also collected in the present study are included in this table.) *: Not native to North America; ‡: Nest parasite; *a*: Taxonomic changes prevent a comparison; *b*: Cannot be definitely identified to species.

DISCUSSION

In addition to simply documenting the undocumented fauna of the northeastern port areas of Baltimore, it is interesting to observe the patterns of abundance in these areas. In contrast to what might be expected, bees were relatively common here. The number of bees per bowl and of bees captured while netting are well within expectations for the region as a whole. Given that there are only ~390 species known from Maryland (John S. Ascher, unpublished list; Mitchell 1960, 1962), many of which have ranges restricted to Western Maryland or the Eastern Shore, or which don't occur in August, 49 species is also a reasonable number to have collected from anywhere in the surrounding area.

To provide context for the unusual proportion of non-native specimens in Baltimore's northeastern port areas, we extracted from our specimen database all records of bees from bowl traps and netting taken by Droege in rural and suburban localities in the Maryland counties of Anne Arundel, Baltimore, Carroll, Harford, Howard, and Prince George's during the month of August from 2001 through 2010. One hundred three species were documented in the region (excluding the specimens from the present study), many of which were very rare species located only in sand barrens along the Patuxent River (Droege et al. 2009). Of the 6512 individuals collected, only the following non-native species were detected: 39 *Anthidium oblongatum* (Illiger), 87 *Apis mellifera* Linnaeus, 12 *Megachile rotundata*, 4 *M. sculpturalis* Smith, and 1 *Halictus tectus* Radoszkowski. These collections were not targeted towards certain species and all specimens captured were processed and identified. Thus the present brief survey of a relatively small area had almost three times more non-native species (11 versus 4) than a more intensive sampling effort over a six-county area of Maryland.

Of the species collected in the present survey, a number represent relatively rarely collected species and are worthy of comment.

Coelioxys coturnix has only very recently been identified from North America, with the first record coming in 2004 from along the Anacostia River in Washington, District of Columbia and subsequent records coming from Northern Virginia and suburban Maryland (John S. Ascher, in litt.), as well as from Baltimore, Maryland and Lehigh County, Pennsylvania. This species is likely to spread as it is thought to be a nest parasite of *Megachile rotundata* (John S. Ascher in litt.).

Halictus tectus is another species only recently detected in North America. This species was first found in 2005 in Philadelphia, Pennsylvania in front of the Philadelphia Museum of Art and subsequent specimens have been found in highly urbanized sites in Beltsville, Maryland, and now Baltimore, Maryland. It

too is likely to spread since similar disturbed sites can be found in any urban area.

Hylaeus punctatus* (Brullé)** has been in North America for some time now (Ascher et al. 2006), but in the East has not been found outside the highly urbanized areas of New York, New York; Baltimore,Maryland; and Washington, District of Columbia. Interestingly, ***H. leptocephalus (Morawitz), another introduced *Hylaeus* species, but one that has been present in North America since the turn of the twentieth century, is also largely restricted to urban areas in the region but has not spread far outside of the Baltimore/Washington metropolitan area.

***Pseudoanthidium nanum* (Mocsáry)** (Figures 2, 3, 4, 5) is the most recently discovered invasive in eastern North America, with specimens first detected in 2008 (Sarah Kornbluth and John S. Ascher, in litt.) in northern New Jersey outside of New York, NY. The three specimens (2 female, 1 male) from the former Bethlehem Steel wire plant at Sparrows Point reported here represent only the second set of records for North America. It remains to be seen how far this species spreads outside of highly disturbed sites.

***Megachile petulans* Cresson** and ***Megachile texana* Cresson** are uncommonly recorded native species in Maryland, with only 2 and 12 records, respectively, outside the present study, as compared with 258 *M. mendica* Cresson and 42 *M. rotundata* records in the USGS Native Bee Inventory and Monitoring Database (Droege, unpublished data). Both the *M. petulans* and *M. texana* records were from the large site of the former Bethlehem Steel wire plant at Sparrows Point, now extensively overgrown with weedy forbs.

***Megachile apicalis* Spinola** is a non-native species from the Mediterranean region. While widespread in the West, it is relatively unrecorded in the East with almost all recent records confined to the New York, New Jersey, Pennsylvania region (Droege, personal observation). Most likely this is due to its pollen specialization on *Centaurea* species and a general lack of collecting. Interestingly, the first record of this species with good locality information that we are aware of was from 1931 in Rosemont, Fairfax County, Virginia on *Centaurea cyanus* L. (Asteraceae), garden cornflower, (University of California, Riverside Entomological Research Museum) (Ascher and Pickering 2011). Mitchell (1962) mentions a female *M. apicalis* without locality information but dated 1882. Mitchell speculated that this species was possibly an unsuccessful introduction. Thus this species likely has remained regionally undetected for long periods of time giving one pause as to what else we may be failing to observe in our local bee fauna.

Figure 2. *Pseudoanthidium nanum* female, lateral view. Netted, northeastern port areas of Baltimore, Maryland, 28 August 2010. (First Maryland records) (Photographed by Kimberly Huntzinger)

Figure 3. *Pseudoanthidium nanum* female, dorsal view. Netted, northeastern port areas of Baltimore, Maryland, 28 August 2010. (First Maryland records) (Photographed by Kimberly Huntzinger)

Figure 4. ***Pseudoanthidium nanum*** **female, frontal view.** Netted, northeastern port areas of Baltimore, Maryland, 28 August 2010. (First Maryland records) (Photographed by Kimberly Huntzinger)

Figure 5. ***Pseudoanthidium nanum*** **male, frontal view.** Netted, northeastern port areas of Baltimore, Maryland, 28 August 2010. (First Maryland records) (Photographed by Kimberly Huntzinger)

The remaining species are all among the commonest and most widespread species in Maryland. The main themes demonstrated here are that even degraded industrial zones contain substantial populations of native bees, but that these sites also harbor more non-native species than would be expected elsewhere. These two opposing patterns, one demonstrating that creation of bee habitat has essentially no limitations in the Mid-Atlantic region and the other demonstrating that invasive species are likely to be fostered by urban habitats, both beg for additional study and demonstrate the capacities that bees have to discover and adapt to novel environments.

This study also documents the complementary nature of using bowl traps and netting. The species list would have been much smaller had only one technique been used. The patterns of which species were captured more often in bowls and more often by netting correspond to our past field experiences, but it should be noted that trap sites and netting sites did not overlap and thus some of these differences are clearly due to location rather than technique, as bowl transects tended to be placed in open lawn or highly disturbed sites and netting took place where patches of taller attractive flowering patches occurred that, based on our experience, would have an abundance of visiting pollinators.

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Bees (Hymenoptera: Apoidea) of the Dominion Cove Point Liquefied Natural Gas Facility and Vicinity, Calvert County, Maryland

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ABSTRACT: The bees of the Dominion Cove Point Liquefied Natural Gas facility and vicinity, Calvert County, Maryland, along the western coast of the Chesapeake Bay, were surveyed in spring, summer and fall. A total of at least 82 species in 27 genera were recorded. Despite the heavily wooded upland nature of much of the site, the relative lack of conspicuous floral resources around most sampling locations, and a fairly low number of captures during the seven total days of sampling, in the course of this survey we caught more than one fifth of the nearly 400 bee species that have been reliably recorded from Maryland. This fraction would be even higher if bees always associated with ecological conditions clearly not present at Cove Point were excluded from the total number of Maryland bee species. Furthermore, given the prevalence in our data set of species captured just once or twice, there is little doubt that additional sampling would yield additional species.

INTRODUCTION

Recently there has been great concern about declines of the managed Honey Bee (*Apis mellifera* Linnaeus) populations, on which much of our agriculture depends in North America and elsewhere. There is strong evidence that many of our relatively well studied bumble bees (*Bombus* Latreille spp.) are declining as well — some quite precipitously (Cameron et al. 2011) — but in general very little is known about the status of the remainder of native species (Winfree 2010). Roughly 800 species of bees occur in North America east of the Mississippi, including more than 390 species known from Maryland (John S. Ascher, in litt.), a total that is likely to continue to gradually increase given the recent uptick in the number of new state records. Many of these bees are important pollinators in both natural and anthropogenic ecosystems.

The bee fauna of eastern North America remains surprisingly poorly known. Although this fauna is far better documented than that of western North America and many other regions worldwide, our knowledge of even basic geographic distributions in eastern North America remains limited. As an illustration of the current inadequacy of our information about bee distributions even in this region, new state records, and often quite rarely collected species, have been discovered on most of the United States Department of the Interior properties

that have been surveyed along the East Coast in the past few years (e.g., Assateague Island National Seashore, Maryland [Orr 2010]; John Heinz National Wildlife Refuge [NWR], New Jersey; Patuxent Research Refuge, Maryland; Carolina Sandhills NWR, South Carolina; and others) (Droege, unpublished). Additionally, these surveys have provided the first documented sets of bee records for each refuge. Carolina Sandhills NWR alone has recently produced approximately 100 new state records for South Carolina (Droege, unpublished). All such local faunal surveys become a baseline for future comparisons and give us perspectives on the distributions, habitat associations, and commonness of bees, facilitating the identification of species of conservation concern and the targeting of locations for management.

As part of an ongoing effort by the Cove Point Natural Heritage Trust to develop a baseline inventory of the biodiversity of Cove Point, Calvert County, Maryland, we undertook a survey of the bees of this area. The results reported here represent a solid foundation for future work.

METHODS

We established 17 sampling sites around the Dominion Cove Point Liquefied Natural Gas facility and vicinity. Eight sites were in the natural areas immediately surrounding the footprint of the plant itself, six sites were in Chesapeake Bay beach swales south of this area, and three sites were just to the west in Cove Point Park along the natural gas right-of-way (Figure 1; Table 1). Steury (2002) provides a detailed analysis of the vegetation of Cove Point. A previous study based on our work in numerous National Wildlife Refuges in USFWS Region 5 (which includes the 13 states from Maine to Virginia) has suggested that sites in moderate proximity such as these can be treated as multiple replicate samples of the same bee fauna (Shapiro and Droege, in prep.).

Of the eight sites in the natural areas immediately surrounding the plant's footprint, Sites 1 through 3 were in open areas around the perimeter of Lake Levy, Site 4 was in a somewhat open area between Lake Levy and Osborne Pond, Site 5 was in a somewhat open area between a wooded stream and a paved work area, Site 6 was along the beach edge of a marsh, Site 7 was on a wooded ridge above the Chesapeake Bay, and Site Sam20 was an open area in woods.

Most bee species do not fly throughout the bee flight season (late March to early October in Maryland). In fact, entire genera may be almost completely restricted to spring or late summer/fall, making it essential to sample across the entire flight season to have even a chance of detecting all bees occurring at a site during the course of a year. We sampled bees on seven dates across the spring, summer, and fall (Table 2). Most sites were sampled on each date, the main exceptions being Sites 16 and Sam20, which were sampled only on 20 March 2008.

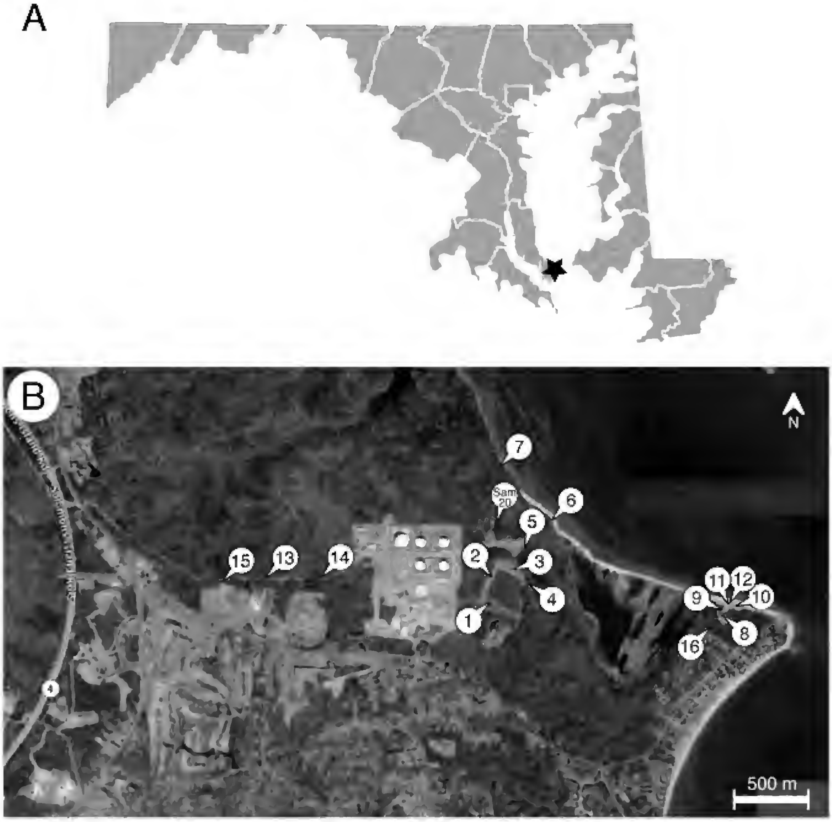

Figure 1. Dominion Cove Point Liquefied Natural Gas facility and vicinity, Calvert County, Maryland. A. location in Maryland; B. sampling sites. (Map adapted from Google maps [2011].)

Our sampling relied mainly on pan-trapping, using what we refer to as "bee bowls" (Droege 2010). Bee bowls are 96.1-milliliter (3.25-ounce) "Solo® soufflé portion cups" painted white, fluorescent blue, or fluorescent yellow, and partially filled with slightly soapy water (Ultra Dawn® blue dishwashing liquid). The bowls were placed on the ground in 15-bowl "transects" (not necessarily in a straight line), with approximately 5 meters (16.4 feet) between bowls. The three bowl colors alternated sequentially within the transect. Bowls were deployed in potential bee habitat for approximately 24 hours.

Grass and other obscuring vegetation were avoided whenever possible. Bees are attracted to the bowls and contact the soapy water, but due to the reduced

surface tension, they sink below the surface and cannot escape. Some bees were netted as well, but at most sites floral resources and bees were few and not conspicuous, making netting impractical.

SITE	LATITUDE	LONGITUDE
1	38.3871	-76.4044
2	38.3887	-76.4044
3	38.3890	-76.4029
4	38.3882	-76.4016
5	38.3905	-76.4019
6	38.3922	-76.3997
7	38.3957	-76.4038
8	38.3863	-76.3869
9	38.3868	-76.3857
10	38.3870	-76.3859
11	38.3871	-76.3864
12	38.3871	-76.3864
13	38.3886	-76.4218
14	38.3886	-76.4176
15	38.3884	-76.4251
16	38.3857	-76.3879
Sam20	38.3921	-76.4041

Table 1. Coordinates of sampling sites at Dominion Cove Point Liquefied Natural Gas facility and vicinity, Calvert County, Maryland.

To estimate true species richness from our sampling, we used EstimateS (Colwell 2006) to calculate the Chao2 and Jack2 nonparametric incidence-based estimators of asymptotic species richness. These estimators are based mainly on the number of sites at which rare species were detected in the original sampling data (Chao 1987; Palmer 1991; Walther & Martin 2001).

Plant names are based on the "The PLANTS Database" of the United States Department of Agriculture, Natural Resources Conservation Service (2011).

RESULTS

In total, across our seven dates and 17 sites, we collected 699 bees, representing a minimum of 82 species. Our collections include representatives of 27 of the 49 genera ever known to have been collected from Maryland and five of the six families known from the state (only the uncommonly encountered Melittidae were absent). Our collections are summarized by date (Table 2) and by site (Table 3). It should be noted that 204 of the 699 bees collected were *Ptilothrix bombiformis* (Cresson), with 198 of these 204 captured on our single July

sampling date, accounting for 70% of the individual bees captured on this date. Excluding our extreme outlier March collecting date, which involved a large number of bowls but yielded a total of just 4 individual bees, we captured 695 bees from 1320 bowls, giving a capture rate of approximately 0.5 bee/bowl, which is a moderately low, but unremarkable yield for bee bowls. The actual capture rate was slightly higher than this since this calculation includes lost and damaged bowls in the denominator.

In fact, our species total is almost surely a bit higher than 82, but in several instances the limits of current understanding of species boundaries preclude identification to the species level. The following "species" in our data set involve such ambiguities:

1) *Hylaeus affinis* (Smith) and *Hylaeus modestus* Say are probably both present in our Cove Point collections, but we cannot yet confidently distinguish females of these two species so we have lumped them together;

2) We almost surely collected more than one species from within the *Lasioglossum viridatum* (Lovell) group, but taxonomic understanding of this group is currently in flux. In Tables 2 and 3, we have recognized three "morphospecies" (*L. viridatum* A, *L. viridatum* B, and *L. viridatum* C), which may or may not turn out to perfectly match valid species recognized in the future, but because of their provisional nature, for species tallies and analyses we pooled these morphospecies as a single *L. viridatum* group;

3) *Nomada* "bidentate" and *Nomada* "white setae" are both complexes of species, the boundaries of which are currently being worked out by Droege and collaborators (Droege et al. 2010); for this report, again using a morphospecies approach, we recognize a single *Nomada* "white setae" form, *Nomada* "bidentate" A, and *Nomada* "bidentate" B. For species tallies and analyses we have pooled these latter two morphospecies under the single name *Nomada* "bidentate";

4) Occasional *Ceratina* Latreille individuals cannot be easily classified as either *Ceratina dupla* Say or *Ceratina calcarata* Robertson (a single individual in this dataset, shown in Tables 2 and 3), but this difficulty does not affect our total species count since both unambiguous *C. dupla* and unambiguous *C. calcarata* are present in our collections. Subsequent to the identification of the material from this project, an additional species, *C. mikmaqi* Rehan and Sheffield, has been identified as occurring at least sporadically in this region (Rehan and Sheffield 2011), but we remain uncertain of how to definitively separate this species from *C. dupla* or *C. calcarata*;

FAMILY	SPECIES	20 MAR 2008	26-27 APR 2008	3-4 MAY 2007	22-23 JUN 2007	21-22 JUL 2007	24-25 AUG 2007	7-8 OCT 2007	TOTAL
Colletidae	*Colletes inaequalis*	1	0	0	0	0	0	0	1
	Colletes latitarsis	0	0	0	1	0	0	0	1
	Hylaeus affinus/modestus	0	0	0	2	0	1	1	4
	Hylaeus ornatus	0	0	0	4	0	0	0	4
Andrenidae	*Andrena banksi*	0	0	2	0	0	0	0	2
	Andrena bradleyi	0	1	0	0	0	0	0	1
	Andrena erigeniae	0	7	8	0	0	0	0	15
	Andrena hilaris	0	0	1	0	0	0	0	1
	Andrena imitatrix	0	0	1	0	0	0	0	1
	Andrena macra	0	1	0	0	0	0	0	1
	Andrena nasonii	0	0	1	0	0	0	0	1
	Andrena neonana	0	0	8	0	0	0	0	8
	Andrena perplexa	0	3	4	0	0	0	0	7
	Andrena vicina	0	1	0	0	0	0	0	1
	Andrena violae	0	1	5	0	0	0	0	6
	Andrena sp.	0	1	0	0	0	0	0	1
	Calliposis andreniformis	0	0	0	0	1	4	0	5
Hallictidae	*Agapostemon splendens*	0	0	0	0	1	0	0	1
	Agapostemon virescens	0	3	2	4	13	3	1	26
	Augochlorella aurata	0	0	7	2	3	0	0	12
	Augochloropsis metallica	0	0	1	0	0	0	0	1
	Halictus confusus	0	0	0	0	1	0	0	1
	Halictus ligatus/poeyi	0	1	0	7	34	4	1	47
	Halictus parallelus	0	0	0	1	0	0	0	1
	Halictus rubicundus	0	0	0	2	0	0	0	2
	Lasioglossum bruneri	0	0	0	2	1	5	0	8
	Lasioglossum callidum	0	1	2	1	1	0	0	5
	Lasioglossum coeruleum	0	0	0	2	0	0	0	2
	Lasioglossum coreopsis	0	1	0	0	1	1	1	4
	Lasioglossum fuscipenne	0	0	0	5	0	0	1	6
	Lasioglossum illinoense	0	0	0	0	0	1	0	1
	Lasioglossum marinum	0	0	0	16	5	2	0	23
	Lasioglossum oblongum	0	0	0	11	4	1	1	17
	Lasioglossum pectorale	0	0	0	1	0	0	0	1
	Lasioglossum pilosum	0	0	1	0	0	0	0	1
	Lasioglossum tegulare	0	0	0	2	0	0	2	4
	Lasioglossum versans	0	0	0	0	0	1	0	1
	Lasioglossum viridatum A	0	0	1	5	0	0	0	6
	Lasioglossum viridatum B	1	0	0	0	0	0	0	1
	Lasioglossum viridatum C	0	1	1	1	0	0	0	3
	Lasioglossum species #1	1	0	0	0	0	0	0	1
	Lasioglossum sp. male	0	0	0	1	0	0	0	1
	Sphecodes coronus	0	6	1	0	0	0	0	7

Megachilidae	*Coelioxys sayi*	0	0	0	0	0	0	1	1
	Hoplitis pilosifrons	0	7	1	0	0	0	0	8
	Hoplitis spoliata	0	0	1	0	0	0	0	1
	Megachile brevis	0	0	1	1	1	0	1	4
	Megachile exilis	0	0	0	0	0	0	1	1
	Megachile mendica	0	0	0	0	5	0	0	5
	Megachile sculpturalis	0	0	0	1	0	0	0	1
	Osmia atriventris	0	1	1	0	0	0	0	2
	Osmia bucephala	0	12	12	0	0	0	0	24
	Osmia collinsiae	0	2	2	0	0	0	0	4
	Osmia conjuncta	0	0	5	0	0	0	0	5
	Osmia georgica	0	0	1	0	0	0	0	1
	Osmia inspergens	0	1	0	0	0	0	0	1
	Osmia lignaria	0	2	0	0	0	0	0	2
	Osmia pumila	0	47	42	0	0	0	0	89
	Osmia taurus	0	1	0	0	0	0	0	1
Apidae	*Apis mellifera*	0	0	0	1	0	0	1	2
	Bombus bimaculatus	0	0	0	7	0	0	0	7
	Bombus fervidus	0	0	0	0	1	0	0	1
	Bombus griseocollis	0	0	0	7	0	0	0	7
	Bombus impatiens	0	1	0	0	0	0	4	5
	Bombus pensylvanicus	0	0	1	0	0	0	0	1
	Ceratina calcarata	0	9	0	0	0	1	0	10
	Ceratina dupla	0	7	0	0	4	4	2	17
	Ceratina dupla/calcarata	0	0	0	0	1	0	0	1
	Ceratina strenua	0	1	0	0	0	0	0	1
	Epeolus lectoides	0	0	0	0	0	1	0	1
	Eucera hamata	0	1	1	0	0	0	0	2
	Habropoda laboriosa	0	0	1	0	0	0	0	1
	Melissodes comptoides	0	0	0	0	0	9	0	9
	Melissodes near *subillata*	0	0	0	1	0	0	0	1
	Melissodes trinodis	0	0	0	1	8	0	0	9
	Melitoma taurea	0	0	0	0	1	1	0	2
	Nomada australis	0	1	1	0	0	0	0	2
	Nomada imbricata	0	0	3	0	0	0	0	3
	Nomada luteola	0	0	1	0	0	0	0	1
	Nomada luteoloides	0	1	0	0	0	0	0	1
	Nomada "bidentate" A	1	0	9	0	0	0	0	10
	Nomada "bidentate" B	0	0	1	0	0	0	0	1
	Nomada "white setae"	0	2	1	0	0	0	0	3
	Peponapis pruinosa	0	0	0	0	0	1	0	1
	Ptilothrix bombiformis	0	0	0	0	198	6	0	204
	*Triepeolus obliteratus**	0	0	0	0	0	0	1	1
	Xylocopa virginica	0	0	0	0	0	2	0	2
Total Individuals		**4**	**124**	**131**	**89**	**284**	**48**	**19**	**699**
Total Species (minimum)		**4**	**28**	**32**	**24**	**18**	**18**	**14**	**82**

Table 2. Bees collected per sampling date. Dominion Cove Point Liquefied Natural Gas facility and vicinity, Calvert County, Maryland. (*: *Triepeolus obliteratus* identity without absolute certainty.)

FAMILY	SPECIES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site Sam20	TOTAL
Colletidae	*Colletes inaequalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Colletes latitarsis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
	Hylaeus affinus/modestus	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	4
	Hylaeus ornatus	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
Andrenidae	*Andrena banksi*	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
	Andrena bradleyi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Andrena erigeniae	1	0	1	1	2	0	5	2	0	0	0	1	1	0	1	0	0	15
	Andrena hilaris	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Andrena imitatrix	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Andrena macra	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Andrena nasonii	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Andrena neonana	0	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	8
	Andrena perplexa	0	0	0	0	2	1	3	0	0	0	0	0	0	1	0	0	0	7
	Andrena vicina	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Andrena violae	3	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	6
	Andrena sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	Calliposis andreniformis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	5
Hallictidae	*Agapostemon splendens*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Agapostemon virescens	1	5	15	1	0	0	0	0	1	0	0	0	2	0	1	0	0	26
	Augochlorella aurata	0	5	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	12
	Augochloropsis metallica	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Halictus confusus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	Halictus ligatus/poeyi	1	4	32	0	0	0	0	1	1	2	0	2	1	2	1	0	0	47
	Halictus parallelus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	Halictus rubicundus	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
	Lasioglossum bruneri	1	0	0	2	0	2	0	0	0	1	1	0	1	0	0	0	0	8
	Lasioglossum callidum	0	0	2	0	1	0	0	0	0	0	0	1	0	0	1	0	0	5
	Lasioglossum coeruleum	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
	Lasioglossum coreopsis	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	4
	Lasioglossum fuscipenne	0	1	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	6
	Lasioglossum illinoense	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Lasioglossum marinum	0	0	0	0	0	0	0	15	1	1	6	0	0	0	0	0	0	23
	Lasioglossum oblongum	0	0	0	0	1	0	1	2	2	0	7	2	0	1	1	0	0	17
	Lasioglossum pectorale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	Lasioglossum pilosum	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	Lasioglossum tegulare	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	4
	Lasioglossum versans	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Lasioglossum viridatum A	0	0	0	0	0	0	0	0	0	0	1	0	1	0	4	0	0	6
	Lasioglossum viridatum B	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Lasioglossum viridatum C	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	3
	Lasioglossum species #1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
	Lasioglossum sp. male	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Sphecodes coronus	0	1	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7
Megachilidae	*Coelioxys sayi*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Hoplitis pilosifrons	0	3	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	8
	Hoplitis spoliata	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Megachile brevis	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4
	Megachile exilis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Megachile mendica	0	1	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	5
	Megachile sculpturalis	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Osmia atriventris	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2
	Osmia bucephala	2	6	6	0	5	0	2	1	1	0	0	0	0	1	0	0	0	24
	Osmia collinsiae	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4

	Osmia conjuncta	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	5
	Osmia georgica	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Osmia inspergens	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Osmia lignaria	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	2
	Osmia pumila	8	18	13	2	25	0	0	5	6	2	1	1	3	1	3	1	0	89
	Osmia taurus	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Apidae	*Apis mellifera*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2
	Bombus bimaculatus	0	0	0	0	1	0	1	2	0	0	0	0	1	1	1	0	0	7
	Bombus fervidus	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Bombus griseocollis	1	0	2	1	1	0	0	0	0	0	1	0	0	1	0	0	0	7
	Bombus impatiens	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	5
	Bombus pensylvanicus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Ceratina calcarata	0	1	2	0	0	0	2	0	0	0	0	0	1	0	0	4	0	10
	Ceratina dupla	0	2	1	0	2	0	0	3	1	1	2	3	0	0	0	2	0	17
	Ceratina dupla/calcarata	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Ceratina strenua	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	Epeolus lectoides	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	Eucera hamata	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
	Habropoda laboriosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	Melissodes comptoides	0	1	2	1	0	0	0	1	1	0	1	2	0	0	0	0	0	9
	Melissodes near *subillata*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Melissodes trinodis	0	1	0	0	0	0	0	0	1	1	0	2	3	1	0	0	0	9
	Melitoma taurea	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2
	Nomada australis	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
	Nomada imbricata	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3
	Nomada luteola	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	Nomada luteoloides	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Nomada "bidentate" A	4	0	0	0	0	0	1	0	1	0	0	0	4	0	0	0	0	10
	Nomada "bidentate" B	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Nomada "white setae"	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3
	Peponapis pruinosa	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
	Ptilothrix bombiformis	7	30	27	9	24	37	4	13	10	13	11	4	7	4	4	0	0	204
	*Triepeolus obliteratus**	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Xylocopa virginica	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Total Individuals		**34**	**92**	**124**	**21**	**76**	**44**	**30**	**67**	**35**	**22**	**38**	**16**	**36**	**27**	**29**	**7**	**1**	**699**
Total Species (minimum)		**14**	**25**	**22**	**11**	**19**	**6**	**14**	**23**	**18**	**8**	**15**	**8**	**20**	**20**	**17**	**3**	**1**	**82**

Table 3. Bees collected per sampling site. Dominion Cove Point Liquefied Natural Gas facility and vicinity, Calvert County, Maryland. (*: *Triepeolus obliteratus* identity without absolute certainty.)

5) Many *Lasioglossum* Curtis males are very difficult to identify to species, although significant progress has been made in recent years (see, especially, Gibbs 2010). We did not count the single such male in our collections as an additional species because it is quite possible that it represents a species we have already collected;

6) Both the more northern *Halictus ligatus* Say and the more southern *Halictus poeyi* Lepeletier likely occur in Maryland, but because we cannot yet confidently distinguish these two species morphologically (Carman and Packer 1996), we list these bees as *H. ligatus/H. poeyi*.

Note that we have included our single "*Andrena* sp." individual in our species tallies as distinct from the other *Andrena* in our collections; although its specific identity is uncertain, it is different from the other positively identified species.

Two additional species are either not yet formally described or have some degree of uncertainty about their identity, but have been included in our tallies and analyses: *Lasioglossum* species #1 and *Triepeolus obliteratus* Graenicher. "*Lasioglossum* species #1" is our informal name for a specimen confirmed by Jason Gibbs (Postdoctoral Researcher, Danforth Lab, Cornell University, Ithaca, New York) who is revising the *Lasioglossum* of eastern North America (Gibbs 2009, 2010) and will soon be formally describing this species (Gibbs, in litt.). (Note: "*Lasioglossum* species #2" occurs in Droege and Shapiro [2011] and is another species soon to be described by Gibbs [in litt.].) The *T. obliteratus* specimen was determined by Molly G. Rightmyer (Research Associate, San Diego Natural History Museum, San Diego, California) who is a leading expert on this genus but was not absolutely certain of the species identification.

As is often the case with surveys of terrestrial arthropods, a large proportion of species were detected only once or a few times. In fact, well over half the species were captured only once or twice (Figure 2 [Note multiple discontinuities along the X axis]). Some of these rarely captured species may have been truly rare at Cove Point during our sampling period, while in other cases apparent rarity may be a sampling artifact (e.g., some species, such as Honey Bees, do not often show up in bowls even if the bees are present). In either case, however, this frequency distribution suggests that our sampling (as is the case for nearly all faunal investigations of bees) is incomplete with respect to the actual number of bee species that could be found occurring at Cove Point. As is typical for bees in eastern North America, the greatest numbers of both species and individuals (ignoring the 198 *Ptilothrix bombiformis* captured in July) were encountered in the spring (Table 2).

Although the documented number of species was only 82 (excluding the three provisional morphospecies), statistical estimators of species richness suggest a true species richness for the sites and dates sampled of ~150 species (Chao2: 153, estimated 95% confidence limits 114 and 243; Jack2: 148). These numbers should be interpreted cautiously as very rough estimates (Colwell 2006), especially given the known tendency of these estimators to underestimate species richness with the degree of incomplete sampling common in real-world surveys (Coddington et al. 2009).

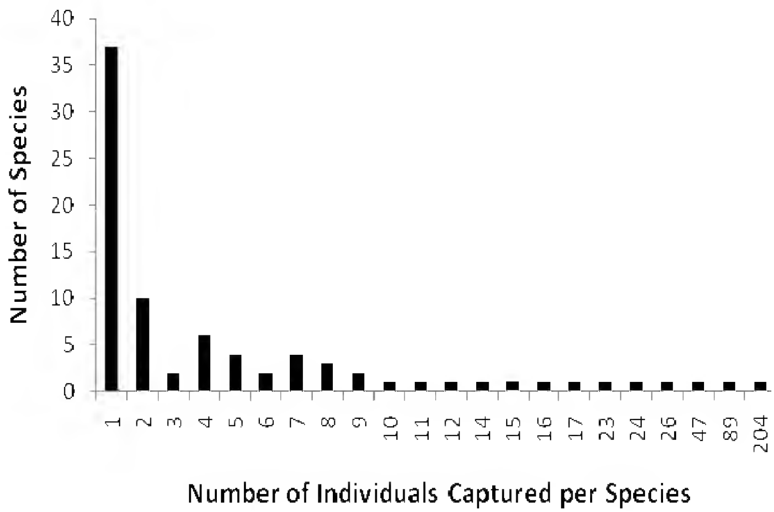

Figure 2. Number of individuals (N = 699) captured per species (N = 82). Dominion Cove Point Liquefied Natural Gas facility and vicinity, Calvert County, Maryland.

SPECIES COMMENTARY

Family Colletidae

Colletes inaequalis Say – This species, although a common pollinator of woody plants in spring, is rarely caught in bowl traps within the region. One individual was caught along a sandy road at its nest with an aquarium net. Several other nesting individuals were noted at the same site.

Colletes latitarsis Robertson – A specialist on weedy groundcherries (*Physalis* L. spp.; Solanaceae). This species is likely under-reported in the region and more common than generally recognized. One specimen was recorded along the pipeline cut.

Hylaeus affinis (Smith)/*Hylaeus modestus* Say – These two species are the most common *Hylaeus* species in the region. Unfortunately, females are not currently thought to be separable by morphology. Four individuals were found across four sites.

Hylaeus ornatus Mitchell – This species appears to be associated with Coastal Plain wetlands and four specimens were captured in an open sandy area behind the beach at Site 8.

Family Andrenidae

Andrena banksi Malloch – An uncommon spring species. Two individuals were found at Site 6 along the beach.

Andrena bradleyi Viereck – An uncommon spring species associated with woodland populations of ericaceous shrubs. One specimen was found at Site 7, which has an ericaceous shrubby understory.

Andrena erigeniae Robertson – A regionally common species usually associated with Virginia spring beauties (*Claytonia virginica* L.; Portulacaceae). This species was recorded from sites throughout the study area, but oddly *C. virginica* was not seen by us nor recorded during an extensive botanical investigation of Cove Point (Steury 2002).

Andrena hilaris Smith – An uncommon species. A single individual was recorded from Site 7.

Andrena imitatrix Cresson – A relatively common species in the region, but here only one specimen was detected (at Site 4).

Andrena macra Mitchell – Regionally, this is an uncommon to rare species and we found just a single individual. Elsewhere in the region, we have usually found this species not far from the Chesapeake Bay or a major river channel, consistent with its occurrence at Cove Point.

Andrena nasonii Robertson – A ubiquitous species of disturbed and woodland sites. One individual was found in the mown areas near Lake Levy.

Andrena neonana Viereck – A spring woodland species, relatively uncommon in the state. We found eight individuals at two wooded sites.

Andrena perplexa Smith – A common, large spring species found at several sites.

Andrena vicina Smith – A common, large spring species.

Andrena violae Robertson – As the name implies, this species is associated with violets (*Viola* L. spp.; Violaceae). This species is common in the region and was found along the pipeline cut and around Lake Levy.

Calliopsis andreniformis Smith – This species is found at highest densities in areas with disturbed compacted soils; scattered individuals were found along the pipeline cut.

Family Halictidae

Agapostemon splendens (Lepeletier) – This species is associated with sandy areas. It is widespread on Maryland's Eastern Shore, but elsewhere in the state it is restricted to small pockets of sand. A single specimen was found along the beach at Site 6.

Agapostemon virescens (Fabricius) – A ubiquitous and common species throughout the region. Captures were concentrated in the mown areas around Lake Levy, with scattered individuals elsewhere.

Augochlorella aurata (Smith) – A regionally abundant species of open fields, this species was found mainly around Lake Levy, with a single individual along the pipeline cut.

Augochloropsis metallica (Fabricius) – While regularly occurring, this species is almost always found in small numbers; we detected it just once, along the pipeline cut.

Halictus confusus Smith – A regionally common member of weedy fields and disturbed areas, a single individual was found at Site 11 just behind the beach.

Halictus ligatus Say/*Halictus poeyi* Lepeletier – These two species are generally considered to be impossible to tell apart morphologically (Carman and Packer 1996); however, our impression after looking at many specimens is that these are most likely *H. poeyi*, which appears to be associated with sandy coastal areas.

Halictus parallelus Say – A regular but uncommon species in the region. One specimen was caught along the pipeline cut.

Halictus rubicundus (Christ) – Similar in appearance to *H. parallelus*, this species is regionally a bit more common and two individuals were detected at Cove Point.

Lasioglossum bruneri (Crawford) – A common species in the region.

Lasioglossum callidum (Sandhouse) – A common species associated with open areas; five individuals were captured in the present study.

Lasioglossum coeruleum (Robertson) – An uncommon species associated with woodlands. We captured two individuals on the wooded ridge at Site 7.

Lasioglossum coreopsis (Robertson) – A common species in the region associated with open areas.

Lasioglossum fuscipenne (Smith) – A common species in the region associated with open areas.

Lasioglossum illinoense (Robertson) – A common species in the region associated with open areas. Only one specimen was captured in the present study, near Lake Levy.

Lasioglossum marinum (Crawford) – A species associated with dunes and coastal beaches. All specimens in the present study were obtained in the open sandy areas behind the beach at Site 8 and adjacent sites.

Lasioglossum oblongum (Lovell) – A regionally uncommon species.

Lasioglossum pectorale (Smith) – A regular species of fields in the region; we captured only one specimen, along the pipeline cut.

Lasioglossum pilosum (Smith) – It was odd to see so few *L. pilosum* in this study. This species occurs commonly in open sites in the region and can be abundant in sandy areas where *L. marinum* also occurs. In the present study only one specimen found.

Lasioglossum tegulare (Robertson) – A common species in the region, associated with open areas.

Lasioglossum versans (Lovell) – An uncommon species. Although usually associated with woodlands, the one specimen detected was found in the open area around Lake Levy.

Lasioglossum viridatum (Lovell) group – The genus *Lasioglossum* is currently undergoing revision and members of this group are thought to represent several species.

Lasioglossum species #1 – This determination was confirmed by Jason Gibbs, who is revising the *Lasioglossum* of eastern North America and will soon be formally describing this species. Gibbs reports that in his experience this bee is fairly common, but never abundant. We have found it regularly in spring woodlands at least throughout the Coastal Plain areas of the Western Shore.

Sphecodes coronus Mitchell – A nest parasite of *Lasioglossum* and possibly other Halictidae.

Family Megachilidae

Coelioxys sayi Robertson – The most common *Coelioxys* in the region and a nest parasite of *Megachile*; this species was detected once (Site 7).

Hoplitis pilosifrons (Cresson) – A regular Coastal Plain species, several individuals were detected around Lake Levy.

Hoplitis spoliata (Provancher) – A less common *Hoplitis* than *H. pilosifrons*, this species was detected in an open sandy area behind the beach at Site 8.

Megachile brevis Say – A common species in the region.

Megachile exilis Cresson – A somewhat uncommon species in the region. One specimen was found in an open sandy area behind the beach at Site 9.

Megachile mendica Cresson – A common species in the region.

Megachile sculpturalis Smith – A very large alien species that favors leguminous plants. One specimen was found in an open sandy area behind the beach at Site 8.

Osmia atriventris Cresson – A regular but usually uncommon species in the region. Two individuals across two sites were detected.

Osmia bucephala Cresson – A regular species in the region, but not usually seen in the large numbers observed at Cove Point.

Osmia collinsiae Robertson – An uncommon spring bee in the region.

Osmia conjuncta Cresson – A regular species in the region, but usually present in low numbers. Here, it was found only in the open sandy areas behind the beach at Sites 8 and 9.

Osmia georgica Cresson – A regular species in the region, but uncommon. A single individual was found in the open sandy area behind the beach at Site 8.

Osmia inspergens Lovell & Cockerell – A regionally uncommon species. A single individual was found near Lake Levy.

Osmia lignaria Say – Regular in the region, but uncommon. Two individuals were found across two sites.

Osmia pumila Cresson – Usually the commonest *Osmia* in the region, although recently the exotic *O. taurus* has become very common near urban centers. This species was very common at Cove Point in all habitats.

Osmia taurus Smith – An alien species. A single individual was found in the open sandy area behind the beach at Site 8, perhaps due to its proximity to the Cove Point community.

Family Apidae

Apis mellifera Linnaeus – Although still a regular part of the Maryland bee fauna, this species is both in decline and tends to avoid bowl traps, as evidenced by having captures from just two sites.

***Note that *Bombus* species are usually detected in bowl traps at apparently lower rates than many other species, although it is possible this is an artifact of their high visibility (Droege, unpublished data).

Bombus bimaculatus Cresson – A common bumble bee; found throughout the study area.

Bombus fervidus (Fabricius) – A regular but much less common species. One individual was found between Lake Levy and Osborne Pond.

Bombus griseocollis (DeGeer) – A common bumble bee; found throughout the study area.

Bombus impatiens Cresson – Regionally, this is by far the most common *Bombus* species, but at Cove Point its abundance was relatively low.

Bombus pensylvanicus (De Geer) – A regionally rare species. One individual was detected around Lake Levy.

Ceratina calcarata Robertson – An abundant species in Maryland, found in most field and woodland habitats. Found throughout the study area.

Ceratina dupla Say – A common species, *C. dupla* seems to favor drier sites than *C. calcarata*, consistent with its commonness in the present study in sandy, scrubby sites near the beach.

Ceratina strenua Smith – A regular species in the region, though less common than *C. calcarata* and *C. dupla*. This species was found only once in our survey.

Epeolus lectoides Robertson – An uncommon parasite of the genus *Colletes*. It is possibly a parasite of *C. latitarsis*. One individual was found in the present survey.

Eucera hamata (Bradley) – A regular, but uncommon, large spring bee of fields in the region. Two individuals were detected in the present study, one around Lake Levy and the other along the pipeline cut.

Habropoda laboriosa (Fabricius) – This species preferentially visits ericaceous shrubs and requires deep sand for its nesting site. Maryland is near the northern limit of its range. A single individual was found in this study, along the pipeline cut.

Melissodes comptoides Robertson – A common coastal plain species. This species was captured both around Lake Levy and in the open sandy areas behind the beach at Site 8 and adjacent sites.

Melissodes near *subillata* LaBerge – Species in this group are often difficult to determine to the species level. Comparison of one specimen captured near Lake Levy with museum collections suggested that it was close to *M. subillata* in its characteristics, but not a perfect match.

Melissodes trinodis Robertson – A common coastal plain species.

Melitoma taurea (Say) – A morning-glory (*Ipomoea* L. spp.; Convolvulaceae) and bindweed (*Convolvulus* L. spp.; Convolvulaceae) specialist. Two individuals were captured.

Nomada australis Mitchell – A likely nest parasite of *Agapostemon*. Two individuals were captured.

Nomada imbricata Smith – Regionally, a common nest parasite of *Andrena*.

Nomada luteola Olivier – A rare parasite of *Andrena*. A single individual was captured along the pipeline cut.

Nomada luteoloides Robertson – Regionally, a common nest parasite of *Andrena*, however only one specimen was captured, near Lake Levy.

Nomada "bidentate": – Members of this group are taxonomically problematic, but all are presumably nest parasites of members of the genus *Andrena*.

Nomada "white setae" – Another group of species with taxonomic problems. They have been left in their own group until better information is available.

Peponapis pruinosa (Say) – A gourd (*Cucurbita* L. spp.; Cucurbitaceae) specialist. A single individual was detected along the pipeline cut.

Ptilothrix bombiformis (Cresson) – In absolute numbers, this was the most common species detected at Cove Point. This species is a Malvaceae specialist and its abundance is undoubtedly due to the large numbers of crimsoneyed rosemallow (*Hibiscus moscheutos* L.; Malvaceae) and Virginia saltmarsh mallow (*Kosteletzkya virginica* [L.] C. Presl ex A. Gray; Malvaceae) plants in the fresh/brackish water wetlands along the Chesapeake Bay.

Triepeolus obliteratus Graenicher – A rare nest parasite of *Melissodes*. A single individual was found in the open sandy area behind the beach at Site 9. This is one of the few records of this species from the East Coast. The species identification was independently confirmed (although without absolute certainty) by Molly G. Rightmyer.

Xylocopa virginica (Linnaeus) – A common species near human habitations. Two individuals were detected.

Collection data for each bee collected in this study are incorporated in the publicly available online database at www.discoverlife.org (Ascher and Pickering 2011). All records for individual species in the database (not only individuals and species from this study) can be viewed using the Global Mapper link (http://pick14.pick.uga.edu/mp/20m?act=make_map).

DISCUSSION

Despite the relative lack of conspicuous floral resources around most of our sampling sites and a fairly low number of captures, in the course of this survey we caught more than one fifth of the bee species known from Maryland; these species represent 55% of the genera that have been recorded from the state. If we were to exclude from the Maryland total the bee species always associated with ecological conditions clearly not present at Cove Point, the fraction of potential bees actually encountered in just seven days of sampling is even higher. Furthermore, given the prevalence in our data set of species captured just once or twice, there is little doubt that additional sampling would yield additional species.

Few surveys of Maryland bees have been published to date. Recent ones have included Patuxent River micro-deserts (Droege et al. 2009), Assateague Island National Seashore (Orr 2010), and Baltimore port areas (Droege and Shapiro 2011). All of these surveys were conducted in habitats that differed from Cove Point; therefore direct comparisons were not attempted. These surveys, as well as the present one, provide important and much needed baseline information

about Maryland's native bees. They contribute important data concerning the current status, distribution and species richness of native bees in Maryland.

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An Increasing Presence: The Lone Star Tick, *Amblyomma americanum* (Linnaeus) (Acari: Ixodidae) in Maryland

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ABSTRACT: The Lone Star Tick, *Amblyomma americanum* (Linnaeus), has expanded its range in Maryland in recent years. The host-seeking seasonality of the larva, nymph, and adult of *A. americanum* is summarized for areas of Maryland where this species has invaded since 1990. Flag sampling showed well established populations of *A. americanum* in western Prince George's and Anne Arundel Counties. An indication of the successful establishment of *A. americanum* in the expansion zone was the presence of dense concentrations of host-seeking nymphs.

INTRODUCTION

In recent years, the Lone Star Tick, *Amblyomma americanum* (Linnaeus) (Acari: Ixodidae) (Figure 1, Figure 2), has been expanding it range and becoming more numerous in areas within its existing range (Ginsberg et al. 1991; Ginsberg and Zhioua 1996; Davidson et al. 1994; Means and White 1997; Childs and Paddock 2003; Lindgren et al. 2005; Carroll 2007). The core of the range of *A. americanum* is the southeastern and south central United States. The range attenuates northward along the Atlantic Coast, with populations on Long Island and Rhode Island (Keirans and Durden 1998). In Iowa, Lindgren et al. (2005) report a northward spread of *A. americanum*. Lone Star Ticks have long occurred in Maryland, but Carroll (2007) documented a westward spread of this species in the state since at least 1990. By 2002, *A. americanum* was distributed mainly east of an imaginary line running approximately from Washington, DC through Baltimore to Cecil County in the northeastern corner of Maryland (Carroll 2007). With the spread of a species into new areas that differ climatically from the core range, some divergence in the seasonal activity of its life stages might be expected in the newly invaded areas versus the core location. Another question is whether the species will prosper in its new area. If the range extension is only marginally tolerable by the invading species, its populations will remain sparse.

As a nuisance biter and vector of *Ehrlichia chaffeensis*, the causative agent of human monocytic ehrlichiosis (HME), *A. americanum* is a tick of public health importance (Childs and Paddock 2003; Goddard and Varela-Stokes 2009).

Figure 1. Lone Star Tick, *Amblyomma americanum*, female, dorsal view. St. Mary's County, Maryland, 5 June 2011. (Photographed by George M. Jett)

Figure 2. Lone Star Tick, *Amblyomma americanum*, male, dorsal view. United States Fish and Wildlife Service, Patuxent Research Refuge, North Tract, Laurel, Anne Arundel County, Maryland, 25 May 2011. (Photographed by Eugene J. Scarpulla)

Stromdahl et al. (2008) reported a high prevalence of spotted fever group rickettsiae in *A. americanum* from Maryland. The active host-seeking behavior and the tendency of its larvae to cluster on vegetation make *A. americanum* quite noticeable to the public (Armstrong et al. 2001).

To complete its life cycle and reproduce, a Lone Star Tick must find a suitable host for each of its three feeding stages (larva, nymph, and adult). A wide variety of small to large vertebrates can serve as hosts for *A. americanum* (Strickland et al. 1976), which predisposes it to be a pest of humans and domesticated animals. However, its principal host is the White-tailed Deer, *Odocoileus virginianus* (Zimmermann) (Patrick and Hair 1977; Bloemer et al. 1988). The extraordinary increase in White-tailed Deer populations in the past few decades may account, at least in part, for an increase in *A. americanum* densities. All three feeding stages of *A. americanum* bite humans.

Because of its medical importance, it is useful to know whether *A. americanum* is developing substantial populations within its new range and what times of the year it poses a risk. The purpose of this paper is to report new and summarized information about the seasonality of host-seeking by *A. americanum* in areas of Maryland newly occupied by this species since 1990 and to learn how successfully this species is established in these areas.

MATERIALS AND METHODS

The methods described below augment extensive tick population sampling conducted primarily 1998 through 2004 as part of the United States Department of Agriculture (USDA) Northeast Area-wide Tick Control Project (Carroll et al. 2009a, 2009b), which focused on tick densities during the peak periods of host-seeking.

Plant names are based on the "PLANTS Database" of the USDA, Natural Resources Conservation Service (2010).

Seasonal Activity

Carroll and Kramer (2003) monitored host-seeking activity at the USDA, Agricultural Research Service (ARS), Beltsville Agricultural Research Center (BARC), Beltsville, Prince George's County to ascertain when '4-poster' deer self-treatment tick control devices needed to be operated in cooler months to target adult Blacklegged Ticks, *Ixodes scapularis* Say, the vector of *Borrelia burgdorferi* spp. *sensu lato*, the causative agent of Lyme disease. Data collected on the other species of ticks captured in that study were not reported. In the early 1990s, *A. americanum* was scarce at BARC, but became well established in areas of the eastern part of the Center by the late 1990s. The surveillance methods are described in detail in Carroll and Kramer (2003). Flaggers used a 0.5 meter by 0.5 meter (1.6 feet by 1.6 feet) white flannel cloth attached to one

end of an aluminum pole. Three sites were flagged two or three times per month from January 2000 through April 2000 and from November 2000 through April 2001. At each site, the flagger walked slowly for 20 minutes along a prescribed route that meandered back and forth between forest and ecotones that bordered dirt roads or cultivated fields. The routes were 600-700 meters (~0.4 mile) in length. By flip-flopping the flag during sampling, the flagger was able to detect nymphal and adult ticks on the flag almost as soon as they clung to the flag cloth. The flag and pant legs of the flagger were visually checked for ticks about every 30 seconds. Captured ticks were counted and removed from the flag and clothing, and released along the route just passed.

Additional sites were flagged in 2009 and 2010 at Greenbelt Park, Greenbelt, Prince George's County. In this case, the flagger walked slowly and checked the flag for ticks after 10 seconds in which the flagger progressed approximately10 meters (~33 feet), as explained more fully in Carroll et al. (2009a, 2009b).

In late August 2010, seven engorged *A. americanum* larvae that dropped from a Domestic Dog, *Canis lupus familiaris* Linnaeus, the previous day were placed in a plastic vial closed with a perforated cap. The vial was placed beneath moist leaf litter under maple trees. After three weeks passed, the molting status of the ticks in the vial was checked twice weekly.

High Densities

Populations of host-seeking nymphs of *A. americanum* and *I. scapularis* have been monitored at John H. Downs Memorial Park (Downs Park), Pasadena, Anne Arundel County, annually on three dates in June through the first week of July from 1998 through 2011. Data from 1998-2007 were reported by Carroll et al. (2009b), and the subsequent sampling was conducted according to the methods described in that paper. At each of 15 sites in the park, after walking slowly for 30 seconds, the flagger identified, counted and removed ticks from the flag and returned them to the route just passed. A total of ten 30-second flagging bouts were done at each site.

A series of collecting trips, four in 2006 and six in 2007, were made mid-June to mid-July to deciduous forests at the United States Fish and Wildlife Service, Patuxent Research Refuge, North Tract (PRR North Tract), Laurel, Anne Arundel County to obtain large numbers of host-seeking *A. americanum* nymphs for various laboratory and field studies. Dominant canopy trees at the collection sites were oaks, *Quercus* L. spp. (Fagaceae); American beech, *Fagus grandifolia* Ehrh. (Fagaceae); blackgum, *Nyssa sylvatica* Marsh. (Cornaceae); sweetgum, *Liquidambar styraciflua* L. (Hamamelidaceae); tuliptree, *Liriodendron tulipifera* L. (Magnoliaceae); and red maple, *Acer rubrum* L. (Aceraceae); with mountain laurel, *Kalmia latifolia* L. (Ericaceae); and sassafras, *Sassafras albidum* (Nutt.) Nees (Ericaceae) being common understory species. Ticks were collected by

flagging leaf litter and low growing vegetation. Because the purpose of the flagging was to collect a large number of ticks, we followed a protocol that facilitated locating and capturing ticks distributed in a clumped pattern. Consecutive (end to end) exploratory transects were flagged, each for approximately 30 seconds while walking slowly. After flagging each transect, captured ticks were counted and collected. If >1 *A. americanum* nymph was found per transect, the direction of the next transect was reversed 180° and roughly parallel to the previous transect. If no ticks were found on the back track, a parallel route on the other side of the exploratory route was flagged. Back tracking along adjacent transects tended to detect areas more densely occupied by *A. americanum*. If ≥10 *A. americanum* nymphs were found, that transect and adjacent transects were flagged in 30-second bouts as long as they yielded nymphs. Exploratory transects were then resumed.

RESULTS

The first host-seeking adults of *A. americanum* found by flagging were captured on warm days ≥18° Celsius (64.4° Fahrenheit) in the shade in mid-March (Table 1). Adults continued to be captured through July. In early May, the first host-seeking nymphs were detected. Nymphs were found by flagging into September. Host-seeking larvae were first detected in late May, but by the later part of June they were not being picked up on flags. However starting in mid-July, host-seeking larvae were found once again and continued to be found into September. The *A. americanum* larvae, which fed on the dog in late August and were held under natural conditions, molted into nymphs in 23 to 27 days (mid to late September). Thus, unfed nymphs and unfed adults (from nymphs that fed during late spring and summer) probably comprise most of the overwintering *A. americanum*. I have not encountered host-seeking *A. americanum* of any life stage west of the Chesapeake Bay from October through the winter.

Stage	Activity Period	Peak
Larva	late May*, early June* mid-July, August, September	August, September
Nymph	early May, June, July, August, September	mid-June to mid-July
Adult	mid-March, April, May, June, July	May, early June

Table 1. Months in which the feeding stages of *Amblyomma americanum* seek hosts in Maryland west of the Chesapeake Bay. (*Larvae captured on flags)

In 2009, there was a sharp increase from the relatively low density years of 2006 and 2007 (~6 nymphs/sample site) to the highest density (>20 nymphs/sample site) in the 14 years of counts at Downs Park (Figure 3). However, in 2010, numbers of nymphs at the park declined by more than 50%.

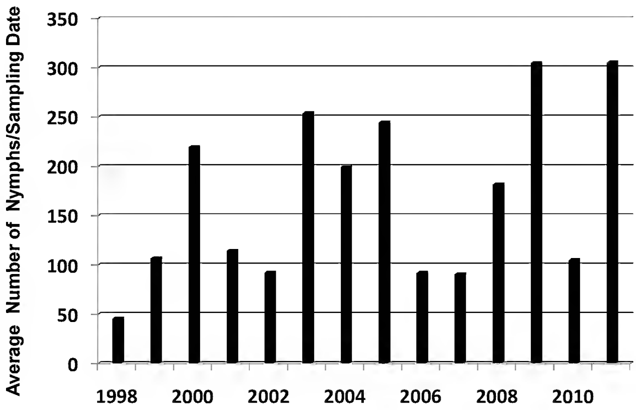

Figure 3. Average total numbers of *Amblyomma americanum* nymphs captured by flagging per sampling date at 15 sites in and around John H. Downs Memorial Park, Anne Arundel County, Maryland. The annual totals were averaged over three sampling dates (late May through early July), except for 2005 and 2011, which had two sampling dates each. Note that although there was a general trend of increasing numbers, year-to-year variation was at times considerable.

Localized concentrations of numerous host-seeking nymphs are characteristic of areas where *A. americanum* has become established in Maryland. Of the 361 *A. americanum* nymphs captured at the 15 sites at Downs Park on the first sample date in 2011, 153 nymphs were captured in a single 30 second subsample. In 2006, when localized concentrations were sought out for collection purposes, one dense focus was discovered that consisted of >300 *A. americanum* nymphs captured in an area approximately 5 meters by 5 meters (~16 feet by ~16 feet). However, the preponderance of ticks was concentrated in a much smaller area within 1.5 meter (4.9 feet) alongside a fallen log. The following year three foci were found. Each focus yielded 400-500 *A. americanum* nymphs from an area approximately 5 meters by 5 meters. In each case within the 5-meter by 5-meter areas, the ticks were particularly concentrated in one or two spots approximately 2 meter by 2 meter (~7 feet by ~7 feet), or in one case along a fallen log. The smaller areas continued to yield ticks after repeatedly flagging. In contrast,

some consecutive exploratory transects extended approximately 400 meters (~0.2 mile) and yielded <5 *A. americanum* nymphs.

DISCUSSION

The onset (early May) and termination (September) of the nymphal host seeking periods reported here are extensions from those reported in Carroll (2007), as is the onset (mid-July) of the main larval host-seeking period. The capture of unfed *A. americanum* larvae on flags in late May/early June followed by a 4 to 6 week disappearance until the major period of larval activity in mid-late summer occurred regularly. Curiously, the early larvae rarely got onto the pant legs of flaggers, whereas flagging in mid-summer required constant vigilance to remove clusters of larvae as quickly as possible from flaggers' pants and footwear. This suggests that the spring larval clusters are not as high on vegetation as the later clusters. In May-April in the Piedmont of Georgia, Davidson et al. (1994) found host-seeking larvae, which they surmised had overwintered. Closer to Maryland, in Virginia, Sonenshine and Levy (1971) recaptured some radioisotope-tagged larvae on hosts during April through July of the year following the year that the larvae were released, but it is unclear whether the overwintering larvae in Virginia correspond to the early larvae in Maryland. Semtner and Hair (1973) noted that host-seeking larvae in Arkansas appeared 2 weeks earlier in open areas than in wooded habitats and that there were two nymphal activity peaks (early June and August-September) in several habitats.

Carroll et al. (2009a, 2009b) established that in Maryland west of the Chesapeake Bay, the peak numbers of host-seeking larvae occur in August and September, nymphs in mid-June through mid-July, and adults in May and early June (Table 1). Host-seeking stages of *A. americanum* overlap rather broadly, particularly nymphs with adults and nymphs with larvae. Some individual ticks start seeking hosts before the peak months and some continue months after seasonal peaks. For instance, I documented an *A. americanum* nymph that had been attached to a human in September (Carroll, unpublished data), well past the nymphal peak which occurred in early summer. Therefore, persons entering *A. americanum* habitats should not let down their guard for this species before October. Stragglers cannot be ruled out totally, but we have not encountered host-seeking *A. americanum* in Maryland west of the Chesapeake Bay from October through December.

Carroll et al. (2009a, 2009b) reported on densities of *A. americanum* at PRR North Tract and Downs Park, from 1998 through 2007. During those years and 2008 through 2011, tick densities fluctuated as much as threefold. The highest numbers of *A. americanum* nymphs recorded for Downs Park on individual sampling dates were >300 nymphs. From 1998 through 2004, densities at PRR North Tract trended somewhat lower than at Downs Park (Carroll et al. 2009a), but by 2004 nymphs were found at all 15 sample sites. At both the Downs Park

and PRR North Tract, densities of *A. americanum* eventually exceeded those of *I. scapularis*. Few American Dog Ticks, *Dermacentor variabilis* (Say) were captured (larvae and nymphs of this species usually are not captured on flags), making *A. americanum* the most prevalent tick that bites humans in those study areas.

Female *A. americanum* are known to lay as many as 8,000 eggs (Strickland et al. 1976) in a mass. The larvae that hatch from the eggs tend to remain together in clumps of hundreds of individuals, thus large numbers of these small ticks can get on a passing host in an instant. Uneven or clumped distributions of host-seeking ticks are rather typical for nymphal and adult ticks too. However, the degree to which it occurs in nymphal *A. americanum* (300-500 nymphs at foci at PRR North Tract) was not encountered with the other two of the three principal species of ticks that bite humans in Maryland, *I. scapularis* and *D. variabilis*. The greatest numbers of *A. americanum* nymphs captured in a single 30-second bout of flagging were 146 and 153 in June 2009 and June 2011, respectively. The limitations of the drag/flag method, such as obstruction by vegetation structure and only collecting ticks that are engaged in questing behavior, may result in the capture of only a small proportion of the total ticks present in the path of the cloth (Sonenshine 1993; Daniels et al. 2000). Other sampling designs involving mark and recapture may better approximate the actual number of ticks in a given area. A spatial sampling design (Thompson and Seber 1996) on a meter scale could provide valuable information, but the capacity of *A. americanum* to readily and rapidly move towards hosts (i.e., investigators) must be taken into account.

In most cases, the extremely dense larval clusters consist of sibling *A. americanum* already in close proximity, having hatched from the same egg mass. Nymphal aggregations require another explanation. Because deer can feed large numbers of *A. americanum* larvae, areas where deer tend to spend time resting or feeding would be expected to have greater densities of *A. americanum* of all stages than areas where deer are scarce or absent. However, dense foci of host-seeking nymphs may be due to the tendency of *A. americanum* larvae to cluster, hundreds acquiring a passing host in an instant, and then after engorging, dropping-off the host somewhat en masse. Drop-off rhythms have been reported for several species of ticks (Sonenshine 1993). Tick larvae do not engorge and drop off in complete synchrony, but hundreds of larvae could leave a host in a few hours. If the peak drop-off for a cluster of *A. americanum* larvae occurred when a deer was bedding or stationary for a few hours, hundreds of fed larvae would be concentrated near the deer. Engorged tick larvae do not move far from the spot where they fall from a host and would thus be aggregated when they seek hosts as nymphs the next year. Because *A. americanum* is an active species (Waladde and Rice 1982) that readily moves toward a host in response to CO_2 and visual and physical cues, hyper-dense foci of nymphs may not endure long in the presence of hosts (Wilson et al. 1972).

The annual counts of *A. americanum* nymphs at Downs Park, 1998-2011, (Figure 3) show generally increasing numbers of *A. americanum* over time, but the pattern is punctuated by abrupt and deep declines followed by recoveries. Interestingly during this period, the years with the highest (e.g., 2001, 2002) and lowest counts (e.g., 2007, 2008) were the same for both *A. americanum* and *I. scapularis* nymphs (Carroll et al. 2009b). This was also the case at BARC (Carroll et al. 2009a). In 2011, the counts of *I. scapularis* nymphs at Downs Park were not high like *A. americanum*, as was the case in other years. This was due to a single dense cluster of *A. americanum* nymphs in one subsample at one site accounting for >40% of the total of that species captured on one sample date.

SUMMARY

Lone Star Ticks appear to be well established in areas of western Prince George's and Anne Arundel Counties in Maryland where they are becoming the predominant threat for human tick bites. Dense foci of *A. americanum* nymphs are an interesting phenomenon, emblematic of the success this species is having in areas where it was scarce two decades ago. Only the period from October to February appears to be risk free of *A. americanum* in these areas.

ACKNOWLEDGMENTS

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THE MARYLAND ENTOMOLOGIST

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COVER PHOTOGRAPH

Adult male Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) feeding on serviceberry, *Amelanchier* Medik. sp. (Rosaceae). Adamstown, Frederick County, Maryland. 12 June 2010.

Photographed by Michael J. Raupp